MODERN
ELECTRO
THERAPEUTICS

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ESSENTIALS OF MODERN ELECTRO-THERAPEUTICS

Essentials of Modern Electro-Therapeutics

An Elementary Text-Book on the Scientific Therapeutic Use of Electricity and Radiant Energy

by

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PREFACE

Physicians who are familiar with the remarkable results which have been obtained from the scientific therapeutic use of Electricity, often express surprise at the ignorance of this subject on the part of the majority of general practitioners. In lecturing on Medical Electricity at Tufts Medical School the author has frequently been interrogated by his students as to the reason for the intense prejudice often freely expressed by prominent members of the profession against the application of Electricity as a therapeutic agent. He has also been asked, "Why do so few Medical Colleges include courses in Electro-therapeutics in their Curricula?" and "Why are so many physicians uninformed regarding the wonderful advances which are being made in our knowledge of Electricity and its relation to Biology and Medicine?" After mature consideration the author has arrived at the following conclusions, or reasons for the professional prejudice against Electro-therapeutics:

First.—Many consider Electro-therapy as a special "School," or form of "Sectarianism," and avoid it as an "Irregular" practice.

Second.—The extravagant claims of "Quacks" and misguided enthusiasts, and the unscientific character of many of the articles on Electro-therapeutics which have appeared in contemporary Medical Journals, have disgusted the more conservative members of the profession.

Third.—The absence of a simple, "Up-to-date," and reliable *Elementary Text-book* has been the greatest, and in some cases, the only reason for the exclusion of Electro-therapeutics from the Curricula of Medical Schools.

In the present work the author has endeavored to produce a Text-book of the above character, not only for students in Medical Schools, but for the individual practitioner who wishes to learn the Theory and Practice of Electro-therapeutics.

The advent of the "Electron Theory" has given us a new standpoint from which to study our environment, and has proven that all Phenomena, whether Physical, Physiological or Chemical, are in reality due to the movement of Electrical Charges, or "Electrons." In the Chapter on, "Physiology from an Electrical Standpoint," the author has endeavored to present old facts in this New Light which has recently illuminated the whole domain of Science.

That this little book may help some of his Professional Brethren to the understanding of many practical problems which he has been obliged to work out in the course of ten years devoted to the study of Electro-therapeutics, is the earnest hope and desire of

THE AUTHOR.

BOSTON, MASS.

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CHAPTER I

MODERN THEORIES OF MATTER AND FORCE

1. Our ideas of all physical and physiological processes have been revolutionized and greatly amplified by the recently discovered "*Electron theory,*" which teaches that all forms of matter are composed of *Negative* and *Positive Electricity* and *nothing else.*

2. The unit of substance is the "*Electron*"—a minute point or center of *Negative Electricity.*

3. According to the Atomic theory, all substance is formed of minute particles called "*Molecules,*" which are constantly swinging through definite Orbits, and which are separated by relatively large spaces.

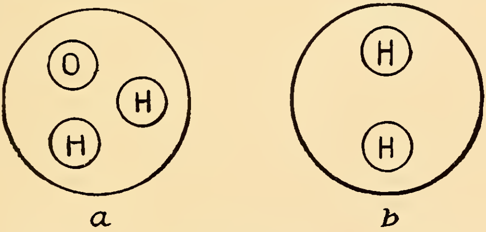

FIG. 1.—*a,* Water molecule of three atoms; H_2O.
b, Hydrogen molecule; two atoms.

4. Molecules are usually composed of two or more "*Atoms;*" the *Atom* does not exist in a free condition except during chemical action, when Molecules are broken up and their Atoms reunite into different Molecules.

5. *Chemistry* is the study of the above process and is based upon our knowledge of the nature and tendency of Atoms to combine to form Molecules.

6. An *Atom* consists of a certain number of *Negative Electrons* floating or suspended in a sphere of *Positive Electricity*. The nature and atomic weight of the different Chemical Elements depends upon the number of Electrons to the Atom; Hydrogen, the lightest Element, has about 1,000 Electrons to the Atom, its atomic weight being 1; Radium one of the heaviest of Elements, has about 200,000 Electrons to the atom, and an atomic weight of 225.

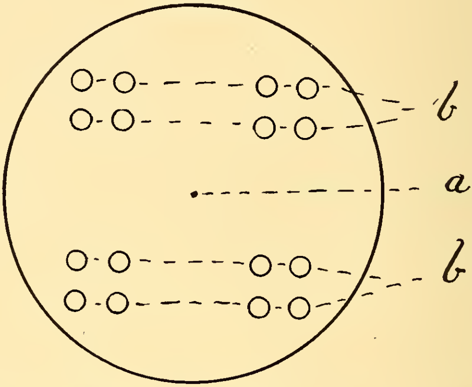

FIG. 2.—HYPOTHETICAL STRUCTURE OF AN ATOM.
a, Center of positive attraction. *b*, Groups of negative electrons symmetrically arranged.

7. The *Electron*, or *Unit of Negative Electricity*, may exist independently of the Atom, and the various forms of Electrical Currents result from the passage of streams of Electrons through Conducting Substances.

8. *Positive Electricity*, on the other hand, does not mani-

fest an independent existence, being always associated with (*Negative*) *Electrons* in the *Atom*.

9. The *Unit of Positive Electricity* is the "*Positive Ion*"—an Atom from which one or two of its Electrons have been temporarily withdrawn, leaving a preponderance of the Positive Electrical influence.

10. In the neutral Atoms of the Molecules, the Positive influence is just balanced by the combined Negative influence of their component Electrons.

11. The Atoms of certain Chemical Elements, notably the *Metals* and *Bases*, may be *temporarily deprived* of one or more *Electrons* and they then become "*Positive Ions.*" (See above.)

12. Atoms of *Acid-forming Elements* readily *attach to themselves* one or more *extra Electrons*, and become for the time being "*Negative Ions.*"

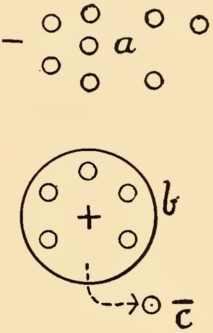

FIG. 3.—*a*, Negative Electrical Units, "Free Electrons." *b*, A Positive Electrical Unit, or Positive "Ion," being an atom which has lost a Negative Electron.

13. From a consideration of the above statements it will be seen that the production of *Chemical Reactions* between different substances results from the conversion of the neutral *Molecular Atoms* into *Ions;* or to put the matter tersely, "*Ionization must precede Chemical Action.*"

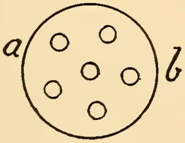

FIG. 4.—*a*, A Negative Ion, being an Atom having normally five Electrons, which has temporarily taken up one electron.

14. *Ionization* is brought about by the increased vibration of the Atoms and Molecules, resulting from the application of some ex-

ternal vibratory force, transmitted in the form of *Ether Waves*, or "*Radiant Electrical Energy.*"

15. The "*Ether*" is a hypothetical Elastic Medium *filling all space;* including the inter-atomic and inter-electronic spaces, as well as those which separate the most distant fixed stars.

16. "*Radiant Energy*" is motion, or force transmitted by the Ether in the form of "*waves*" or "*transverse vibrations.*"

17. These "*Ether Waves*" are produced solely by the periodic *vibration* or *rotation of Electrons.*

18. Motion or vibrations of *collections of Molecules* or *Masses* are called *Mechanical movements,* and do not produce radiant waves in the Ether. A tuning fork, for example, sets up mechanical vibrations or *Sound Waves* in the air, but does not disturb the surrounding ether. A lighted candle, on the other hand, gives out Radiant Ether Waves of *Light* and *Heat,* as a result of the intense vibrations of electrons in the flame; yet it produces no mechanical waves in the air.

19. The Electrons in the different kinds of Atoms have different rates of vibration, and consequently produce Ether waves of different *frequencies* and *wave-lengths.*

20. The slowest, longest Ether waves known at the present time are called "*Hertz waves,*" and result from the vibrations of Electrons in the *Spark-discharge of a Leyden Jar.*

21. Higher in the scale come the "*Heat waves,*" caused by the Electronic vibrations attending Chemical combinations; or by the increased motion of Atomic Electrons resulting from collision or friction between moving Masses. In short, *wherever friction occurs, Heat waves are produced.*

22. Next in order are the *Light waves* which result from the rapid vibration of the Electrons of matter in the so-

called *luminous state,* resulting from combustion, electrical discharges, etc. The term "*Light*" is restricted to about one octave, comprising vibrations between 350 million-millions (Red light) and 450 million-millions (Violet light); vibrations below and above these limits do not affect the retina of the human eye.

23. Between the upper limit of vision and a vibration of one thousand-million-millions are the so-called *Ultra-violet rays* which affect photographic plates, discharge electrified bodies and produce chemical changes in living tissues. Certain sensitive substances such as *Willemite, Calcium Tungstate,* etc., give out light rays when exposed to Ultra violet vibrations; this phenomenon is called *Fluorescence.*

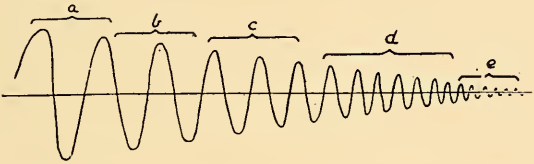

FIG. 5.—DIAGRAM INDICATING WAVE LENGTH AND FREQUENCY OF KNOWN FORMS OF RADIANT ENERGY.

a, Hertz Waves. *b,* Heat Waves. *c,* Light Waves. *d,* Ultra-violet Rays. *e,* Roentgen ("X") Rays.

24. The most rapid form of Ether vibrations yet studied are the X-rays of Roentgen which result from the sudden stoppage of free Electrons moving at a high rate of speed in an exhausted bulb at a pressure of one one-millionth of an atmosphere. The X-rays affect photographic plates like light, cause phosphorescence in sensitive substances, and possess great powers of penetration; the X-rays are absorbed by solid bodies in proportion to the density of the latter; this property is the basis of "Radiography," by

which shadow pictures of the bones, etc., are obtained on photographic plates. Frequent or long exposures to X-rays cause grave effects on the trophic nerves and vital resistance of the superficial tissues of the body, followed in a week or more by severe Inflammation and Necrosis.

CHAPTER II

THE FUNDAMENTAL LAWS AND PRINCIPLES OF ELECTRO-PHYSICS

1. *Electricity* is a term applied to the phenomena which result from the movement of *Electrons* through *Masses*.

2. Substances are divided into two classes:—

(a) *Conductors* of Electricity.

(b) *Non-conductors* of Electricity, or *Insulators*.

Conducting bodies, such as metals, allow electrons to move through them as water flows through a pipe. Non-conducting bodies resist the passage of electrons.

3. A mass from which Electrons have been temporarily withdrawn is called a *Positively-charged body;* a mass to

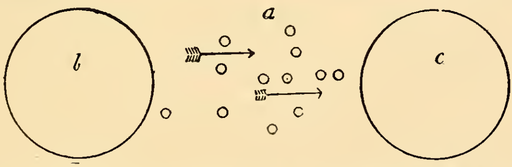

Fig. 6.—*a*, Group of Electrons moving from the mass (*b*) to the mass (*c*). *b*, Remains *positively* charged. *c*, Becomes *negatively* charged.

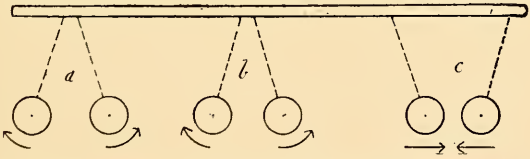

Fig. 7.—*a*, *b*, Bodies of *Like Charge* (or polarity) showing mutual repulsion. *c*, Bodies of *Unlike Charge* showing mutual attraction.

which Electrons have been temporarily added is called a *Negatively-charged body*.

4. Bodies having *like charges repel* each other; bodies having *unlike charges attract* each other.

5. A Stream of Electrons flowing through a Conductor is called an *Electrical Current*.

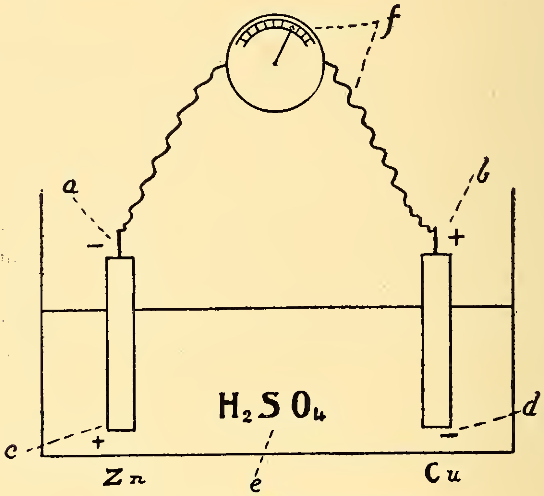

Fig. 8.—Simple Battery Cell.

a, Negative *Pole*. *b*, Positive *Pole*. *c*, Positive *Plate*. *d*, Negative *Plate*. *e*, Electrolyte (dilute Sulphuric Acid). *f*, External Circuit with Galvanometer indicating current.

6. An Instrument capable of maintaining an Electrical Current in a Conductor is called an *Electrical Generator*.

7. A Generator is in reality a *Transformer of Energy*:—
   (a) A Generator which transforms the energy of *Chemical Action* into Electricity, is called a *Battery*.
   (b) One which converts *Heat* into Electricity is called a *Thermo-Electric Generator*.

(c) A Generator of Electricity from *Mechanical Force* or *Friction,* is called a *Static Machine.*

(d) A Generator which converts *Mechanical Force* first into *Magnetism* and then into Electricity is called a *Magneto,* or *Dynamo-Electric Machine.*

8. The simplest form of *Battery* consists of a plate of Copper, and a plate of Zinc covered with Mercury, immersed in diluted Sulphuric acid; if the Zinc and Copper be connected by a conducting wire, chemical action will commence in the solution, the Zinc being gradually dissolved in the Sulphuric Acid, forming Zinc Sulphate and Hydrogen Gas; the Chemical process causes a withdrawal of Electrons from the Copper plate, an equal number of Electrons being simultaneously forced into the Zinc plate; and in this way a continuous *Uni-directional Electrical Current* or *Stream of Electrons* flows through the metallic Conductor from the Zinc to the Copper plate.

9. The direction of the Electronic Stream in the solution is therefore opposite to that in the conducting wire, and in this way a complete circular path or *Circuit* is formed. The Copper plate from which the Electrons flow in the solution, is called the *Negative Plate;* its upper extremity to which the conducting wire is attached, is called the *Positive Pole* of the Battery; the Zinc being the *Positive Plate* and its upper terminal being the *Negative Pole.* These terms were applied years ago when Electricity was believed to flow from the Positive to the Negative Pole, and from the Positive to the Negative Plate. We now know, however, that the Stream of Electrons really moves in the *reverse direction,* that is from *Negative* to *Positive.* This fact should be borne in mind in order to avoid confusion.

10. A Stream of Electricity flowing through a Conductor possesses attributes and properties analogous to those of a

Stream of Water falling from a height or flowing through a pipe; in the latter instance the amount of water flowing through the pipe in a given time and the size and diameter of the stream, would depend upon the *size, length* and *resistance* of the pipe, taken in connection with the *speed of the stream*, or the *pressure* which causes it to flow. Similarly, Electricity of a given *Pressure* or *Potential*, will create a current of a certain *Volume* or *Intensity* in a conducting path or circuit of a given *Resistance*.

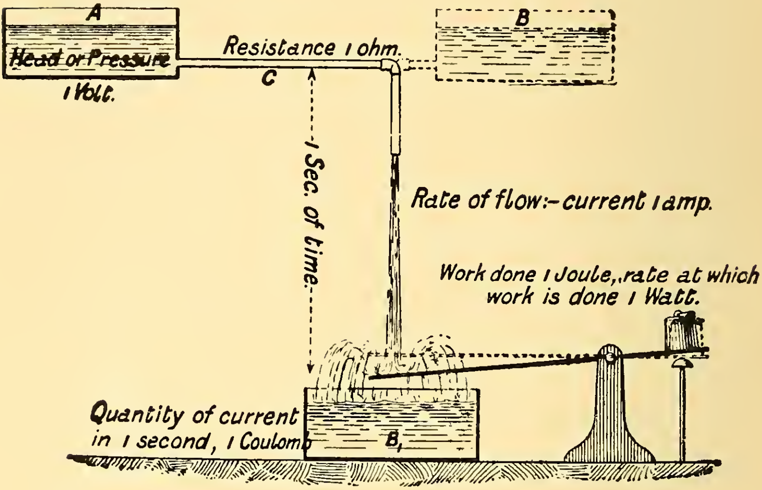
A
Head or Pressure
1 Volt.
Resistance 1 ohm.
C
B
1 Sec. of time.
Rate of flow:- current 1 amp.
Work done 1 Joule, rate at which work is done 1 Watt.
Quantity of current in 1 second, 1 Coulomb
B₁

FIG. 9.—DIAGRAM SHOWING ANALOGY BETWEEN FLOWING WATER AND A CURRENT OF ELECTRICITY.
(From Williams' High Frequency Currents.)

11. (a) The Electrical Unit of Pressure or Potential is the "*Volt*."

(b) The Electrical Unit of *Volume* or *Intensity* is the "*Ampere*."

(c) The Electrical Unit of *Resistance* is the "*Ohm*."

12. The Volt is to an Electrical Current what the pound per sq. in. is to a stream of water; it gives us an idea of the Electrical Pressure; that is, the "*Electro-motive force.*"*

The maximum pressure produced by a single battery cell, such as described in Section 8, is approximately one Volt.

13. The Ohm, or Unit of Resistance is represented by a column of Mercury one meter high and one millimeter in diameter.

14. A pressure of one Volt acting on the Resistance of the above Mercury column, will cause a current of exactly one Ampere to flow through the latter.

15. If two of the three factors, Voltage, Amperage and Resistance are known, the third factor may be found by the use of a formula called "*Ohms Law.*" This formula may be stated in three ways, as follows:

$$C = \frac{E}{R}; \quad R = \frac{E}{C}; \quad E = C\ R;$$

in which,

"C" = *Current volume in Amperes.*
"R" = *Resistance in Ohms.*
"E" = *Electro-Motive Force in Volts.*

16. Batteries may be connected in two ways called *Series* or "*Cascade,*" and *Multiple* or *Parallel.*

17. If a number of cells,—say five,—are linked by short wires so that the Positive pole of one cell is joined to the Negative pole of the next, they are said to be in "*Series;*" and the Current obtained from them will be of the same Amperage as that from a single cell, while the Voltage will be five times as great.

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*In Physics this term is represented by the abbreviation "E. M. F."

18. If, on the other hand, all the Positive poles of the above five cells be joined to one end of a circuit, while all the Negative poles are joined to the opposite end, the Batteries will be in "Multiple" or "Parallel;" and the Current generated will have five times the Amperage, but the same Voltage as that produced by a single cell.

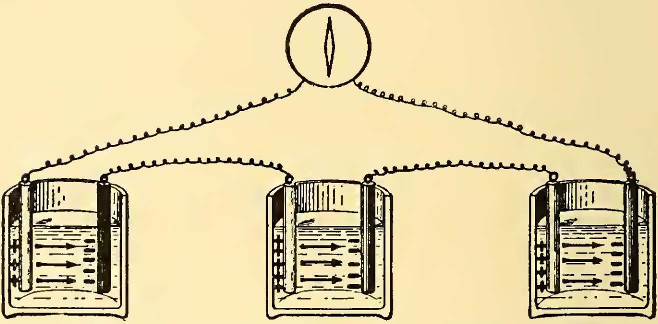

FIG. 10.—BATTERIES IN SERIES (Williams).

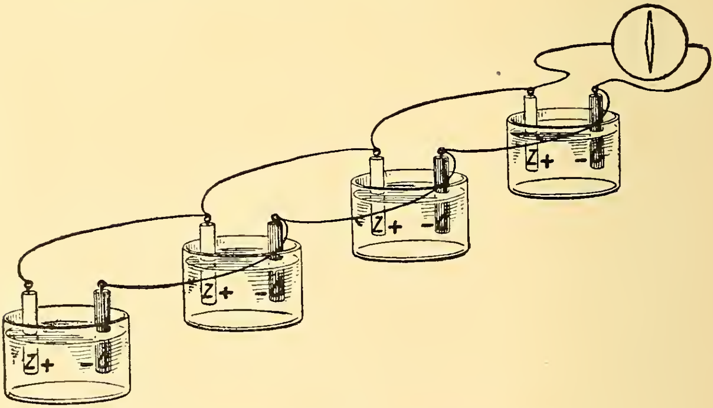

FIG. 11.—BATTERIES IN PARALLEL (Williams).

19. A *Static Machine* generates a Continuous Electrical Current of High Voltage and Low Amperage. The older forms consisted of glass plates revolving in contact with silk-covered rubber pads; the friction caused Electrons to be drawn from the surface of the glass into the silk; and the Positive charge thus imparted to the surface of the revolving disk was drawn off by stationary Brass Combs or *Collectors*, attached to an insulated Brass Sphere called the "*Prime Conductor*;" when the hand was brought within a short distance of this Conductor, a bright spark was produced and

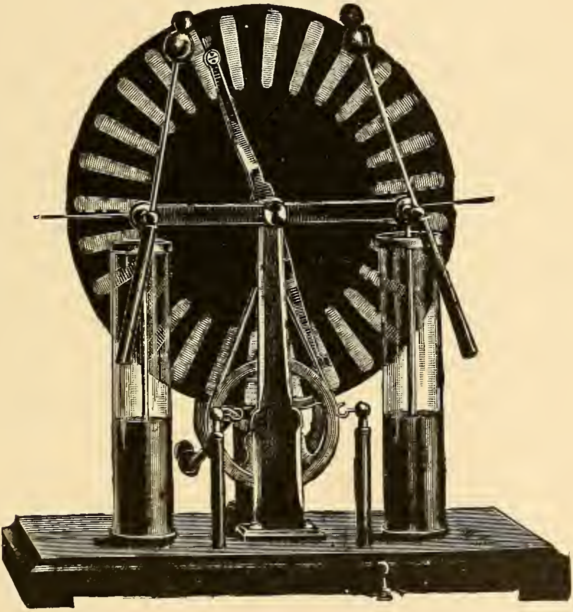

FIG. 12.—A SMALL STATIC MACHINE OF THE WIMSHURST TYPE (Williams).

a transitory Current of High Voltage flowed through the body into the ground. The Currents from a Static Machine will gradually leak away into the air from *Metal Points* or *Edges,* but do not readily escape from *Rounded Surfaces* unless a Conductor is brought near them; hence, Points are used on the Collecting Combs, while the Prime Conductor is Spherical or Oval.

In the Modern Static Apparatus such as the *Holtz Machine* an *Initial Charge* from a small Frictional Apparatus is communicated to a paper sector mounted upon a stationary glass plate; a circular glass disk revolves in front of the stationary plate, and when opposite the paper sector is charged inductively;—the *front* of the disk being charged *oppositely* to the sector, the "*like charge*" being repelled to the *back* of the disk, where it is drawn off by a grounded Collecting Comb; the single Charge now remaining in the disk is then drawn off by a second Comb connected to one of the Terminals of the Machine. In this way a powerful, Continuous Current is produced, the process being known as *Electrostatic Induction.* The Charges produced on the glass plate are formed of *Negative* and *Positive Ions,* rather than *free Electrons,* as in the case of Battery Currents.

20. The production of Electricity in the Holtz Machine by Electro-Static Induction is an application of the principle of the "*Condenser,*" or "*Leyden Jar.*" This device consists, in its simplest form, of a *glass plate* which separates *two metal plates* of slightly smaller area. If a Negative Charge be communicated to one of the metal plates, Negative Ions will be distributed over the adjacent surface of the glass. These Ions act inductively through the glass plate, converting the particles on its opposite surface into Negative and Positive Ions, attracting the "unlike" Positive Ions into the second metal plate. If the latter be temporarily connected

to a grounded wire the Negative Charge will be driven into the earth, leaving the Condenser charged on the one side with *Negative*, on the other with *Positive Electricity*. In the familiar type of Condenser, known as the *Leyden Jar*, a wide-mouthed bottle is used instead of a glass plate, coated on the

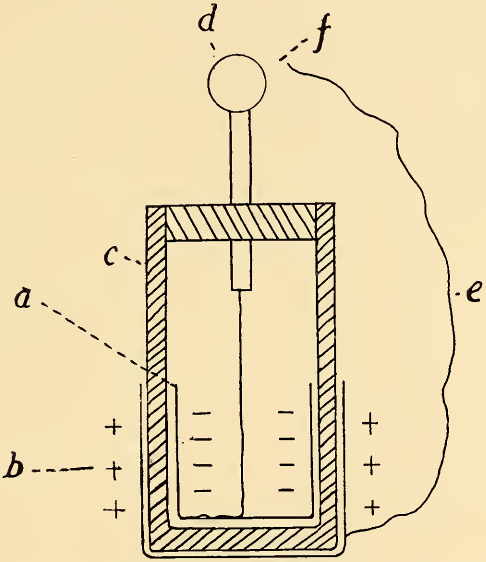

FIG. 13.—LEYDEN JAR, OR CONDENSER.
a, Inner Coating. *b*, Outer Coating. *c*, Glass Jar. *d*, Brass Ball Terminal. *e*, Discharging Wire. *f*, "Spark-gap."

inside and outside with tin-foil, the charge being communicated to the inner coating by means of a Brass Ball and Chain supported by the stopper of the bottle.

21. If a wire be connected with the outer coating of a Leyden Jar, and its other end brought near the Brass Ball connected with the inner coating, a *bright white spark* will be

formed between the Knob and wire, and a Current or Stream of Electrons will flow through the latter. This Stream of Electrons seems to *acquire Momentum,* and instead of ceasing when electrical equilibrium has been established, the Current will continue until the Jar is charged in an *opposite direction;* the coating which was originally Positive is now Negative, and vice versa. All this takes place during an extremely small fraction of a second, before the incandescent air particles in the path of the spark have had a chance to cool, and a second discharge immediately ensues in which the Electrons move through the wire in a direction *opposite* to that of the *initial discharge;* in this way a *series* of *Alternating Discharges* or *Electrical Oscillations* are set up in the circuit formed by the *wire,* the *"spark gap,"* and the *two coatings of the Leyden Jar;* each Oscillation being less powerful than the preceding one, so that they gradually die away and the Jar is left in an uncharged condition. The Electrical Oscillations may be compared to the motion of a fluid in a glass "U" tube when air pressure has been applied to one arm of the tube and suddenly released;—the fluid will alternately rise and fall, — each movement being slightly less than its predecessor, — until equilibrium is established.

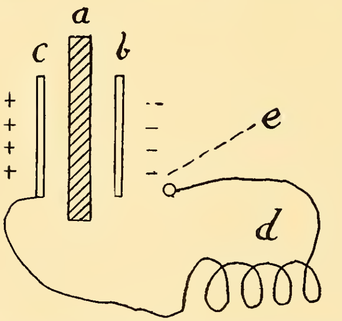

FIG. 14.—PLATE CONDENSER, WITH INDUCTANCE COIL.

a, Glass Plate. *b,* Negative Plate. *c,* Positive Plate. *d,* Inductance Coil. *e,* Spark-gap.

22. If a Coil formed of several turns of coarse wire be included in the Discharging Circuit of a Leyden Jar, the Oscillations will not die down so rapidly and the number

of Alternating Impulses resulting from each Primary Condenser Discharge will be much greater than in a circuit without the Coil.

23. When *Ions*, or *Electrons* are suddenly brought from a condition of rest to one of motion, or vice versa,—a *Magnetic Action* is transmitted through the surrounding Ether, which affects the Electrons in any adjacent Conductor; thus a sudden rush of Electrons through a Coil of wire produces a similar transient movement in a second Coil of wire wound concentrically with the first Coil. This is called "*Electro-Magnetic Induction.*" When the Electrical Impulses are extremely short and rapid, they produce inductive effects upon adjacent convolutions of the same Coil in which they flow. This is called "*Self Induction.*" By suitably adjusting the size, and number of turns of wire in the Coil to the Frequency of the Oscillations, we can cause the Self-Induction to either *retard*, or *accellerate* the passage of the current; a Coil which is designed to *obstruct* the Current by its Self-Induction, is called an "*Inductive Resistance*" or "*Choke Coil.*" Such Coils are used to control or regulate Commercial Alternating Currents in the same manner that Coils of high "Ohmic" resistance, (*Rheostats*) are used to regulate *Direct Continuous Currents.*

24. The Frequency or Number of Oscillations per Second, depends on the size or "*Capacity*" of the Condenser. When an Inductance Coil is so constructed as to *augment* or *prolong* the Series of Oscillations produced by each Primary Discharge of a Condenser of given Capacity, we have what is called a "*Tuned System.*" When such a System is connected with a device for *re-charging* the Condenser as soon as each set of Oscillations die out, the arrangement is called a "*High-Frequency Apparatus*;" and the Inductance Coil is known as a "*d'Arsonval High-Frequency Solenoid.*"

25. If to one end of the Solenoid is attached a Coil of fine wire wound in a single layer or Spiral, and the second Coil be *tuned* to the same *Frequency*, as the Solenoid,—the two coils are said to be in a condition of "*Electrical Resonance.*" The second Coil is called an "*Oudin Resonator,*" and from its free upper Terminal, a *Current of High-Frequency* may be obtained, of a *Potential* or *Voltage very much higher* than that of the *Solenoid Circuit.*

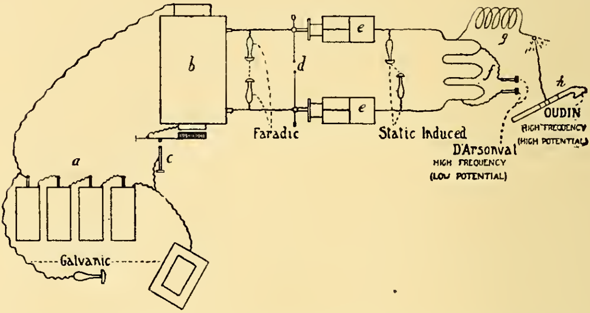

FIG. 15.—DIAGRAM OF OUDIN-D'ARSONVAL HIGH-FREQUENCY APPARATUS, SHOWING INTERMEDIATE FORMS OF CURRENT.

a, Batteries in "Series." *b*, Induction Coil. *c*, Vibrator or Interrupter. *d*, Spark-gap. *e*, Condensers or Leyden Jars. *f*, d'Arsonval "Solenoid." *g*, Oudin "Resonator." *h*, "Vacuum" Electrode.

26. When used for Therapeutic purposes, the Solenoid and Resonator are usually excited by two Leyden Jars, which are charged from a Ruhmkorff Coil or large Static Machine. The discharge from the Resonator is necessarily *Uni-polar.*

27. In order to obtain *Bi-polar Currents* of High Frequency and High Potential, a fine wire Coil similar, but smaller than the Resonator, is used; but instead of being connected to the Solenoid, it is slipped over the latter, and

the two are separated by a layer of Insulating Wax or Oil. *Resonance* between the two coils, while desirable, is not essential, inasmuch as the High Voltage Current is produced in the fine Coil through the *Electro-Magnetic Induction* of the *Oscillating Electrons in the Solenoid.*

28. The two Coils just described constitute a "*Tesla-Thompson High-Frequency Transformer,*" the fine wire, or Secondary Coil, being commonly referred to as the "*Tesla Coil.*" This type of Apparatus is usually associated with a Condenser formed of a number of flat plates of Glass or Mica, separated by sheets of Tin-foil, and the Charging Current is obtained from a "*Step-up Transformer,*" having a *Closed Magnetic Circuit,* excited by a Commercial Alternating Current of Low Voltage and Frequency.

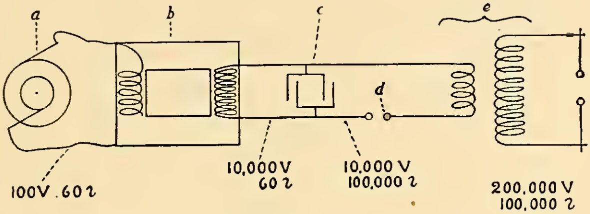

FIG. 16.—TESLA-THOMPSON HIGH-FREQUENCY APPARATUS.

a, Alternating Current Generator. *b,* "Step-up" Transformer. *c,* Condenser. *d,* Spark-gap. *e,* Tesla-Thompson High-frequency Transformer.

29. The principle of Electro-Magnetic Induction, exemplified in the *Tesla Coil,* is employed in the transformation of Currents of less Voltage and Frequency in a somewhat different manner. In the Tesla Coil a High Voltage Current is obtained by the *direct Inductive action* of the High Frequency Current in the primary Solenoid;—in Low Frequency Transforming Devices the Primary Current first in-

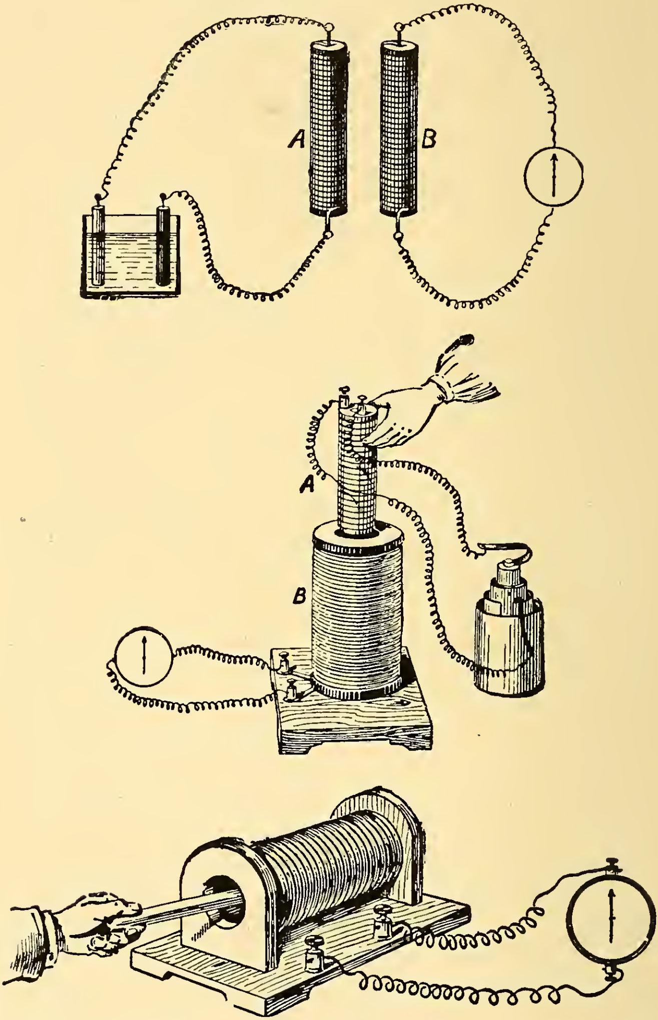

Fig. 17.—*a,* Mutual Induction. *b,* Electro-Magnetic Induction. *c,* Magnetic-Electric Induction (Williams).

duces *temporary Magnetism* in a *Soft-iron "Core."* and this in turn induces the Current in the Secondary Coil.

30. The term *"Magnetism"* has been used to describe certain properties which are found in the element *Iron,* and in several other Metals in a lesser degree. When a Current is passed through a Coil surrounding a bar of Iron, the latter becomes temporarily Magnetic, Electrons being driven out of each Iron Atom in a direction opposite to that of the current in the coil. When the Current ceases, each Electron moves back into the Atom, and in so doing sets up *Radiating Ether Waves* which induce a momentary Current in a Secondary Coil wound outside of the Primary. If *Steel* is used instead of *Soft-iron,* the Electrons remain fixed outside of the Atoms and a *Permanent Magnet* results.

31. When such a Magnet is introduced into a Coil of wire, a Current Impulse is induced in the latter; when the Magnet is withdrawn, a similar Impulse is induced in the opposite direction. By continuously moving a Magnet in and out of a Coil, or by revolving a Coil between the poles of a Magnet, a succession of Alternate Impulses is produced which constitute an *"Alternating Electrical Current."* By suitably arranging the revolving Coil in reference to the Magnet, the Alternating Impulses may be made to rise and fall smoothly and regularly like the waves upon the surface of a pond when a pebble is dropped into its center. The *Electrical Waves* so produced form what is called a *"Sinusoidal Current."*

32. To transform an Alternating Current, so produced, from a Low to a High Voltage, it is passed through a Primary Coil wound upon one side of an Iron Core shaped like a hollow Square; on the opposite side of the Core is wound a Secondary Coil of longer and finer wire, in which the High Voltage Current is induced. If a High Voltage Alternating Current be passed through the Secondary Coil, a current of Low

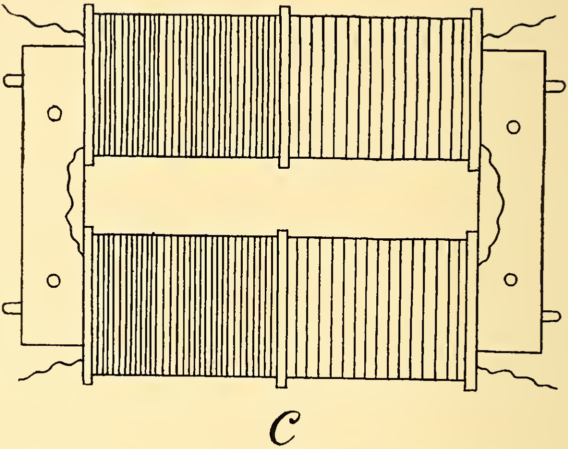

Fig. 18.—Alternating Current Transformer.

For "stepping-up" a current from 110 volts to 15,000 volts; coils are wound on a closed magnetic circuit of thin plates of "electrical steel."

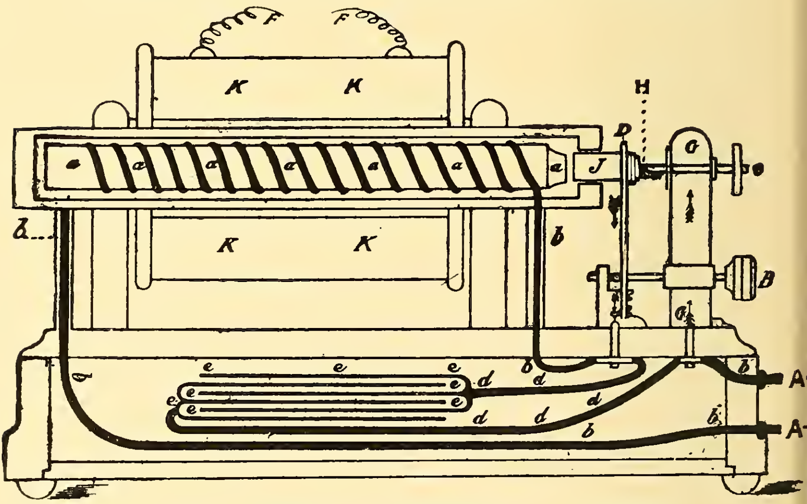

Fig. 19.—Diagram of Induction Coil (Williams).

Voltage will be induced in the Primary Coil. When used in this way the device is called a "*Step-down Transformer;*" when used to transform a Low Voltage Current into one of High Voltage it is called a "*Step-up Transformer.*"

33. To obtain a High Voltage Current from a Continuous Direct Current of Low Voltage, a transforming Device called an "*Induction Coil*" is used. This consists of a straight Core of Soft-iron, upon which is wound a coarse Primary Coil; over this in turn, is wound a fine wire Secondary Coil. The Direct Current used to excite the Primary Coil is periodically interrupted in order to produce the Inductive Impulses.

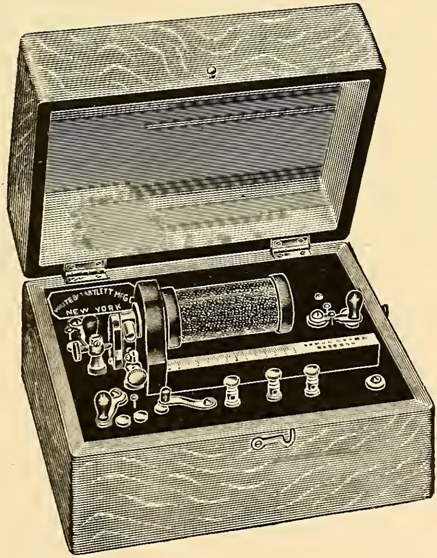

FIG. 20—SMALL FARADIC COIL.

34. The "*Faradic Coil*" is a small form of Induction Coil used for Therapeutic purposes. The Primary Current is ob-

tained from Battery Cells, and is interrupted by means of a Spring Vibrator actuated by the Magnetism of the Iron Core. The Secondary Coil is made to slide over the Primary so as to regulate the strength of the Induced Currents.

35. For the production of powerful High Voltage Currents for exciting X-ray tubes or High-Frequency Apparatus, a form of Induction Coil is employed which is known as the "*Ruhmkorff Coil.*" Its Secondary Coil contains thousands of feet of fine wire wound in thin sections or insulated layers. Its Primary is usually excited by the 110-Volt Direct Incandescent Light Current, which is interrupted by a *Mechanical* or *Electrolytic* "*Break.*" A Condenser, consisting of a number of sheets of tin-foil, separated by waxed paper, is usually mounted in the base of the Ruhmkorff Coil for the purpose of absorbing, or neutralizing the so-called "*extra current,*" which is self-induced in the Primary Coil at each interruption of the Current.

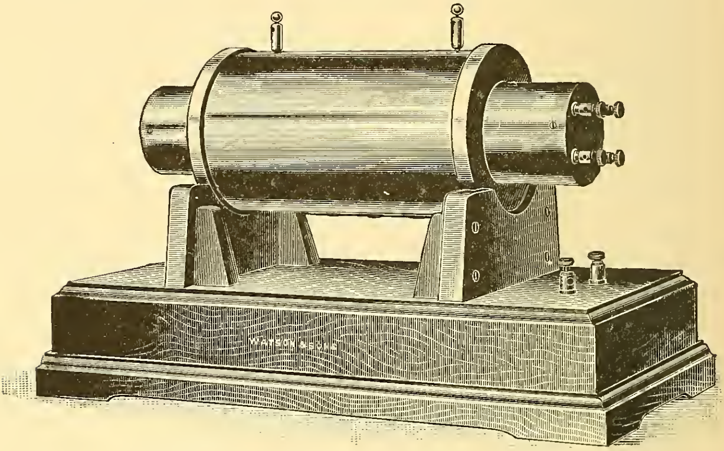

FIG. 21.—"RUHMKORFF" INDUCTION COIL.

CHAPTER III

PHYSIOLOGY FROM AN ELECTRICAL STANDPOINT

1. The Human Organism may be compared to a Symphony Orchestra; the different Instruments representing the various Organs, while the individual Players may be likened to the Peripheral Nerves and Ganglia of each Organ, controlled and supervised by the Conscious Intelligence through the Central Nervous System, analogous to the Conductor or Musical Director.

2. Suppression or alteration of any one Function disturbs the equilibrium of the whole body, just as a single Instrument playing out of tune will destroy the harmony of an entire Orchestra.

3. The growth and functional activity of the Human Body is maintained by the Potential Energy stored up in the food. This food is derived directly or indirectly from Vegetable substances.

4. *All Energy* comes primarily from the *Sun* in the form of *Radiant Heat Waves.* This heat is absorbed by Vegetable Organisms, and is used to break up Carbon Dioxide, from the atmosphere, into Carbon and Oxygen. The Carbon is combined with Water to form the organized structure of the plant or tree. The Oxygen is given back to the atmosphere. The *Radiant Solar Energy* is thus transformed into *Potential Chemical Energy* which is stored up in the Carbon of the plant, on one hand, and freed Oxygen on the other. It is this stored-up energy which is employed in the Animal Or-

ganism for the performance of the different physiological functions. Thus the energy expended in lifting a weight involves the re-combination in the muscle fibers of the Carbon obtained from the digestion of food with atmospheric Oxygen brought from the Lungs by the Red Blood Corpuscles.

A consideration of the above facts shows the fundamental difference between Animal and Vegetable Organisms. The latter absorb active Heat Energy and breathe CO_2, returning Oxygen to the atmosphere and building up Carbon compounds in which Potential Energy is stored. Animals, on the other hand, break down the Vegetable Carbon Compounds which are burned up in the Cells of the Organism with Oxygen from the air, the stored-up Energy being liberated in an active, or Kinetic form, and Carbon Dioxide being returned to the atmosphere.

5. It will be seen, therefore, that the maintenance of Health and Vital Activity in the Human Organism depends upon the digestion and absorption of sufficient Organic Food Material, and upon the inspiration and distribution of sufficient Oxygen to supply the combustion in the Cells.

6. The following Functions are concerned in the preparation and distribution of the Food Material and Oxygen.

(a) The *Digestive System*, in which the food is mechanically softened and disintegrated and then rendered soluble by Chemical Ferments.

(b) The *Absorbent System*, in which the digested food is taken from the Intestine and transferred to the Blood Stream.

(c) The *Distributory System*, including the Blood Vessels and Lymphatics, which carry the absorbed nutriment to all parts of the body.

(d) The *Respiratory System*, comprising the Lungs, which draw in Oxygen, and the Red Blood Corpuscles, which carry this Oxygen to all parts of the body.

(e) The *Excretory System*, which frees the body from the burned-up Cell Débris, and the products of tissue combustion. The gas CO_2, is brought by the Blood returning from the different parts of the body to the Lungs, when it is unloaded, while the Red Corpuscles are absorbing a fresh load of Oxygen. Solid waste particles are picked up by the *Leucocytes*, or White Blood Corpuscles, and carried to the *Spleen*, where they are completely burned up. These Leucocytes are the "Police," as well as the "Scavengers" of the body, picking up and carrying away Disease Germs or poisonous substances accidentally introduced through Wounds. When any part of the body is cut or torn, these Leucocytes form a wall, preventing foreign matter from gaining access to the Blood Stream; and in the same way they surround developing masses or "Colonies" of Disease Germs, thus checking their development and protecting surrounding tissues. The little seed-like Nodules which form in the Lung in the early stages of Consumption are collections of the Bacilli of Tuberculosis which have been walled in by Leucocytes in the above manner. These Nodules are called "*Miliary Tubercles*."

The White Corpuscles also aid the body to throw off Infectious Disease by forming Soluble Chemical Antidotes, which neutralize the poisonous products of the Bacteria. Diphtheria Antitoxine is an Antidote of this kind, formed by the Leucocytes of the Blood of a Horse, which has been gradually *immunized* to Poison obtained from Diphtheria Bacilli, artificially grown in the Laboratory.

(f) All of the above functions are maintained and regulated by *Electrical Vibrations*, or *Oscillations*, transmitted through the *Nerves* of the so-called *Sympathetic System;* which consists of a great number of *Nerve Filaments* radiating from the Center or collection of Nerve Cells in the Abdomen called the *Solar Plexus*.

7. In the last paragraph we have considered the various processes by which the Cells and Tissues of the Human Body are supplied with the Potential Energy necessary for the performance of their respective functions; and incidentally we have explained the manner in which the Organism is protected from the action of Disease Germs and their poisonous products. We will now discuss the functions which involve the *dispersion* of the Energy taken in in the form of "*Food*."

8. The most important of these functions has its seat in the *Muscular System*, and involves the conversion of the Potential Energy supplied by the food, into Active, or Kinetic Mechanical Force. The Muscular System comprises,—the *Voluntary Muscles*, which contract only under the influence of a Conscious Electrical Impulse transmitted from the Brain to the Motor Nerves through the Spinal Cord; and the *Involuntary Muscles*, which are independent of Consciousness or Volition; they are associated with the mechanical processes incidental to Digestion, Circulation and Respiration. They are operated by Electrical Vibrations originating principally in the *Solar Plexus*, and transmitted through the Nerves of the *Sympathetic System*.

9. The *Sensory Mechanism* also involves the dispersion of stored-up Energy. Through the various Sensory Nerves we are enabled to come into conscious relation with the objective world which we interpret through *Vibrations*, of different types and frequencies. Almost all parts of the Body are

provided with sensitive, Bulb-like Structures called "*Tactile Corpuscles,*" each of which is connected to a Sensory Nerve Filament which passes through the Spinal Cord to the Center of Sensation in the Brain. These Filaments pass through large Nerve Cells in the Spinal-Cord which act like *Batteries,* supplying the Electrical Energy for the Vibratory Impulses which cause Sensation.

The exact electrical nature of Sensory Nerve Impulses is not known. It is probable, however, that each Sensory Nerve with its terminal Bulb acts as a *Condenser,* and that stimulation or irritation of the Nerve-end causes this Condenser to *discharge,* producing *Electrical Oscillations of a definite Frequency,* varying in intensity or amplitude according to the degree of stimulation. Slight contact between the Skin and a soft substance would set up faint Oscillations, which would be transmitted to the Brain and interpreted as a delicate tactile sensation; severe irritation or abrasion of the Skin, on the other hand, probably causes a complete "short-circuiting" of the Nerve Condenser, resulting in Oscillations of great intensity, which give rise to a Conscious Sense of Local Pain.

10. Finally, we have the so-called "*Special Senses.*"—*Sight, Sound, Taste, and Smell.* The nature and range of the Vibrations which affect the Human Ear and Eye have been considered in a previous Chapter. The Frequency of Vibration in the Nerves of Taste and Smell has not been determined. They are probably closely allied to ordinary Tactile Sensations.

11. The various types of Nerves, whether Sensory, Motor or Sympathetic, transmit to their respective organs and tissues a peculiar vitalizing influence called "*Trophic Force.*" This action, which was formerly believed to possess a special System of Nerve Filaments, is now known to be a *common*

function of all Nerves; in other words, each Nerve possesses a so-called *Trophic Center,* which continually supplies the Nerve and its respective tissues with the peculiar Vibratory Force necessary for their growth and vital action. The Trophic Centers of the Motor Nerves are in the Anterior Horns of the Spinal Cord. The Sensory Nerves have their Trophic Centers in small Ganglia which lie just outside of the Posterior Roots of the Spinal Cord. The significance and importance of the Trophic Centers is shown by the study of Diseases involving their Degeneration. For example,—in certain types of Lateral Sclerosis which involve certain Trophic Centers,—the Muscles corresponding to the latter *atrophy,* and practically disappear. In cases of Motor and Sensory Paralysis, on the other hand, where the Trophic Centers are not affected, the Muscles remain for a long time without much diminution in size. Attention is called to this point, in order that a correct idea may be obtained regarding the character and importance of *Trophic Nerve Force.* Although denied by certain Physiologists, it is becoming more and more generally believed by progressive Physicians, that the great majority of Diseased Conditions have, as their *primary* or *predisposing Cause,* a *diminution* or *weakening* of the *Trophic Supply* of different parts of the Body. By the use of certain forms of *Electrical Oscillations,* (High-Frequency Currents),—we can *temporarily supply Trophic Force where it is lacking,* and in so doing restore function, promote nutrition and assist the Leucocytes in removing and destroying Disease Germs and their poisonous products.

CHAPTER IV

GALVANISM

1. In a previous Chapter we have seen that Radiant Waves in the Ether result not from the mere motion of Electrons, but from Vibrations or Impulses involving the sudden passage of Electrons from a state of *Rest* to one of *Motion,* or vice versa. In like manner, Nerve Vibrations are not excited by the passage of a Constant Current through the body, but are invariably produced by the *sudden increase* or the *interruption* of such a Current.

2. If a number of Battery Cells be connected in Series, and their Terminal Wires be connected to two wet Sponge Electrodes in contact with the Human Body, a Continuous, Unidirectional Stream of Electrons will flow through the latter. This is called a *Galvanic Current,* and, as the Voltage from the Series of Cells is relatively low, and the Resistance of the Body is very high, it will be seen by referring to "Ohm's Law,"—(See Chapter 2),—that the *Volume* of such a Current will be but a *small fraction* of an *Ampere.*

3. This being the case, we employ in Electro-therapeutics a Unit of Volume or Intensity called the "*Milliampere*" which is equal to one one-thousandth of an Ampere.

4. The Resistance of the Human Body is confined principally to the skin and averages from 2,000 to 5,000 Ohms. It may be much less, or much greater than this, according to the condition of the skin, the nature of the Electrodes, and the size of the surface that they cover. It is an important Rule in Galvanism, *that the Resistance of the Body be made as low as possible.* This is accomplished by wetting the surface with Salt Solution, after washing with Soap and warm

water and by using Electrodes, having as large an area as is practicable.

5. In most instances, Galvanism is used in the treatment of *Local Conditions*, and the Terminal which is applied to the Diseased Area is called the "*Active Electrode.*" This should be of small size in order to concentrate, or intensify the Local Electrical Action. The other Terminal is attached to what is known as the "*Passive, or Indifferent Electrode,*" which should be of large size so as to lessen the Resistance. An efficient Indifferent Electrode can be made from a piece of Block-tin or Sheet-lead, having a Binding Post attached to one corner. This is wrapped with several layers of Surgical Gauze, soaked in Salt Solution, and applied to the Abdomen of the Patient. It can be molded to fit any other part of the Body if desired. An equally good plan is to use a small tub of warm Salt Solution for the Indifferent Electrode, the feet of the Patient being immersed in the Conducting Fluid.

6. A Galvanic Current for Therapeutic use may be obtained from Battery Cells connected in Series, or from a 110-volt Direct Incandescent Light Circuit.

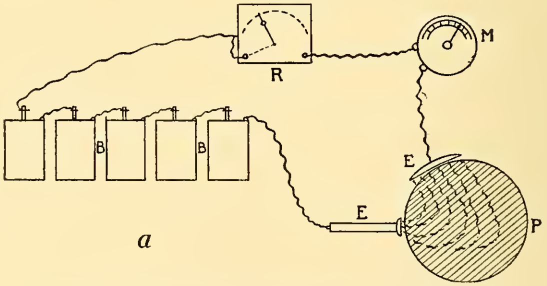

FIG. 22.—BATTERIES ARRANGED TO PRODUCE THE GALVANIC CURRENT.

B B, Cells in series. *R*, Variable Resistance. *E*, Mil-ammeter. *E E*, Electrodes. *P*, Body of patient.

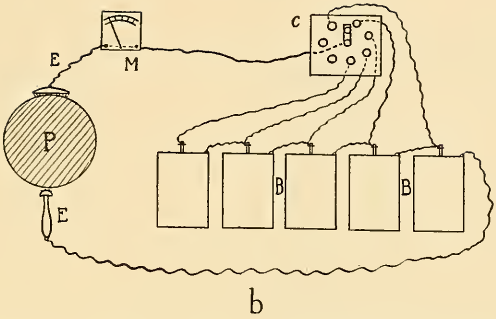

Fig. 23.—Galvanic Outfit with Cell Selector, *C*.

7. If Batteries be used, they are connected in Series, and the strength of the Current is regulated by an adjustable Rheostat. Another method of regulation is to connect the wires between each Cell with the points of a Rotary Switch called a "*Cell Selector,*" which permits the use of any desired number of Cells in the series.

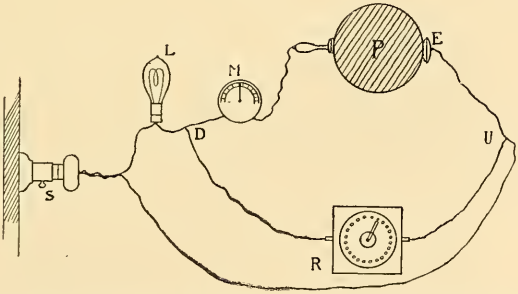

Fig. 24. — Arrangement for Obtaining a Galvanic Current from the 110-volt Direct Current (the Edison Light Current).

S, Lamp socket, plug and cord. *L*, 16 c. p. lamp which limits the flow of current. *D*, Point at which the current is divided into two "shunt" circuits. *M*, Mil-ammeter. *E E*, Electrodes. *P*, Patient. *R*, Variable Rheostat.

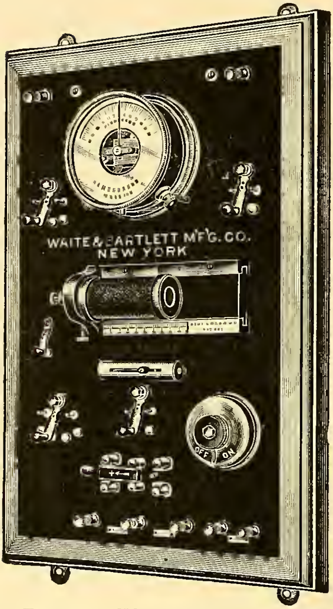

Fig. 25.—Wall Plate for Use with 110-Volt Edison Direct Current.

8. In order to adapt the Direct Incandescent Light Current for Therapeutic use, a device called a "*Shunt Coil*" is used. The 110-Volt Current first passes through a small Incandescent Lamp and is then split into two parts, one of which passes through the variable Shunt Coil, and the other through the Body of the Patient, after which the two branches of the Circuit re-unite and return to the "Mains." By varying the Resistance in the Shunt Coil, a greater or less amount of Current is diverted to the Patient's branch of the Circuit.

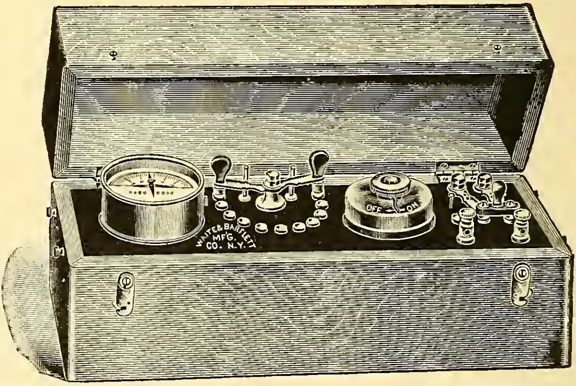
WAITE & BARTLETT MF'G. CO. N.Y.
OFF
ON

Fig. 26.—Portable Galvanic Outfit with Both Cell-Selector and Rheostat.

9. Every Galvanic Outfit should be provided with an Instrument for measuring the amount of Current which is passing through the Body of the Patient. Such a device is called a "*Milliampere Meter,*" which is commonly abbreviated to "*Mil-ammeter.*" It consists of a Galvanometer, having a Permanent Magnet with a pivotal Coil between its Poles. A Pointer attached to the Coil, moves over a Graduated Scale; and the passage of a Galvanic Current through the Coil causes a movement of the Pointer corresponding to the strength of the current. The Scale is graduated so as to indicate the number of Milliamperes passing through the

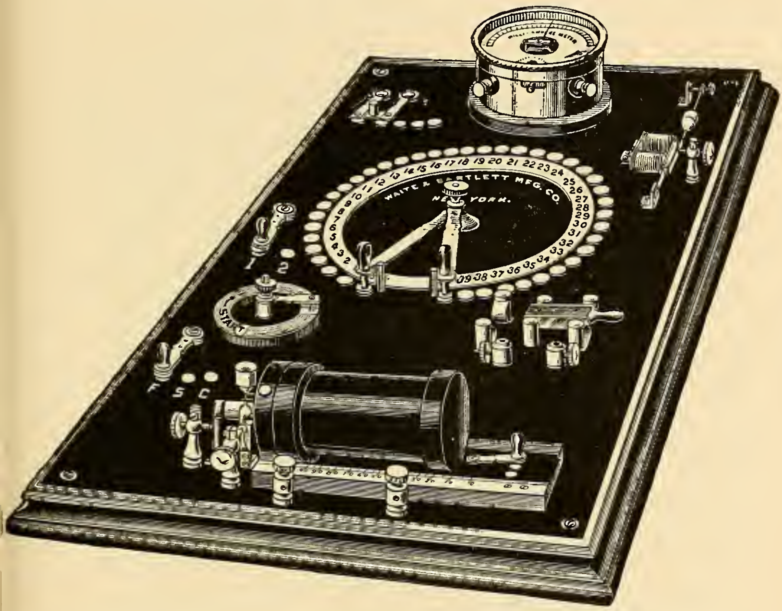

FIG. 27.—GALVANIC AND FARADIC WALL PLATE FOR USE WITH BATTERY CELLS.

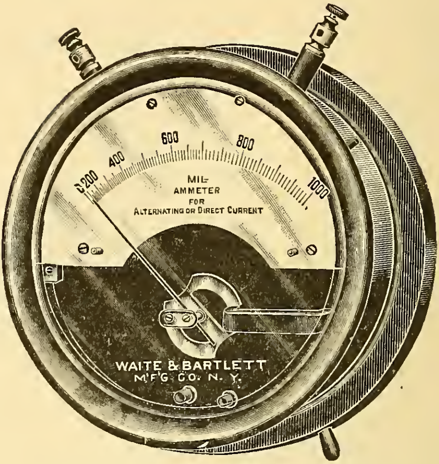

FIG. 28.—HOT WIRE MIL-AMMETER.

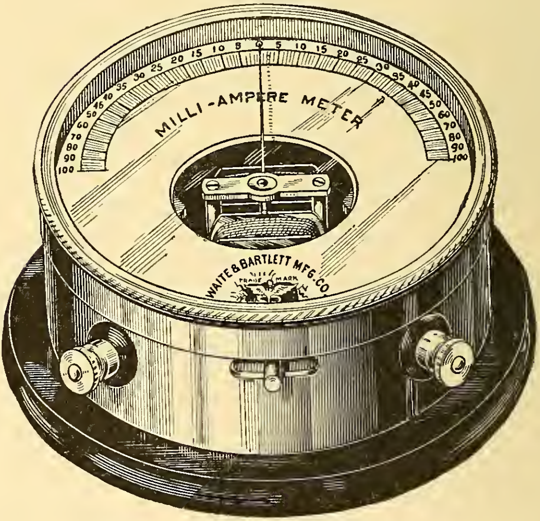

FIG. 29.—MAGNETIC MIL-AMMETER.

Patient. In some Instruments a Stationary Coil is used, which acts upon the pivotal Soft-iron Armature, mounted between the Poles of the Magnet. In still another form

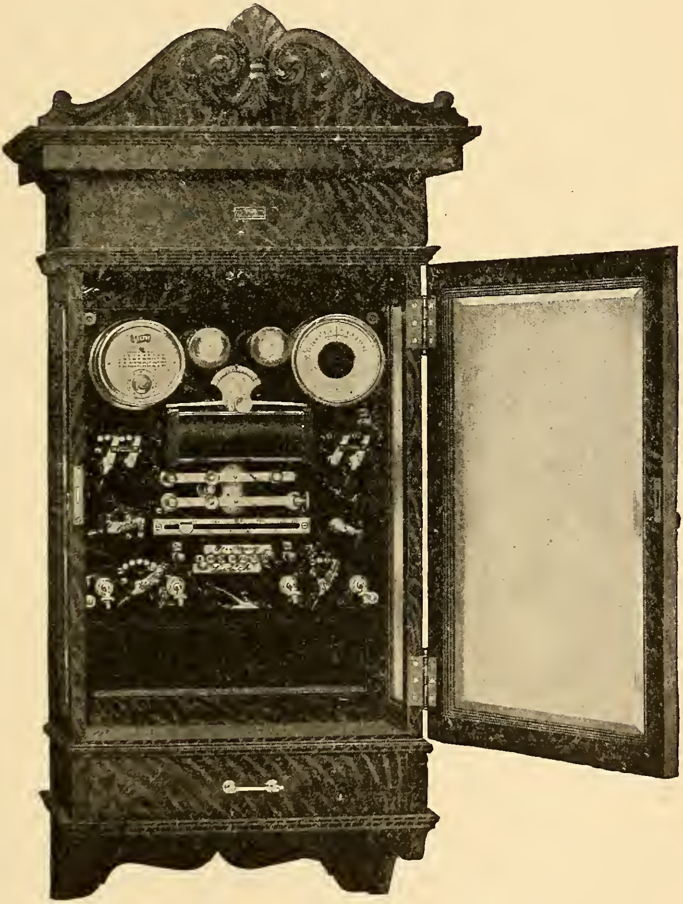

Fig. 30.—Wall Plate for Use with Edison Current.

of Instrument, the Current passes through a very fine Platinum Wire, which becomes heated in proportion to the Volume of the Electrical Stream, the change in length thus produced, causes the rotation of a delicate *Pivot* carrying an indicating Needle. The Hot Wire Meter, just described, possesses a great advantage over Magnetic Meters as it may be used equally well for the measurement of a Galvanic, Alternating, or High-Frequency Current. For this reason it has been styled the "*Universal Galvanometer*." The Magnetic Meters, first described, can be used only with a Continuous or Galvanic current.

10. In choosing a Galvanic Outfit, when the Direct or "Edison Current," cannot be obtained, it will be necessary to employ Batteries. For a stationary Office Outfit, "Wet Cells" of the *Carbon-cylinder Type* are generally used; the "*Electrolyte*" or *Charging-fluid*, consisting of a strong solution of Ammonium Chloride,—("Sal Ammoniac"). For most purposes, from twenty to thirty Cells will be sufficient. For a Portable Outfit, Dry Cells should be employed, such as are used with Electric Bells, and for Automobile Coils. These Cells cannot be re-charged, but can be replaced for a comparatively small sum. The so-called "Chloride of Silver Dry Cells" are of very small size, and a Battery of 100 cells can be carried in a case a foot square. A serious objection to their use, however, is their extremely high Internal Resistance, and they are suitable only for treatments which require a Current of very small Volume, such as Electro-diagnosis and the removal of Facial Blemishes. In administering Galvanism, the Electrodes should first be applied and the Current should then be very gradually increased from zero until the required strength or Volume is indicated by the Milammeter. At the end of the treatment the Current should be shut off in the same gradual manner. The Therapeutic

action of Galvanism may be considered under the following heads:

(a) *General Galvanization,* when the Current is used for its effect on the entire Organism.

(b) *Local Galvanization,* where a circumscribed area is subjected to the Physiological action of the *Positive* or *Negative Pole,* according to the effect desired.

(c) *Positive Electrolysis,* in which local effects result from the Chemical action of a Zinc or Copper "*Anode*" or *Positive Electrode.*

(d) *Negative Electrolysis* or local destruction of tissue by the Alkaline products at the "*Cathode*" or *Negative Electrode.*

(e) *Cataphoresis,* or *Electrical Osmosis,* which involves the carrying into the tissues of Medicinal substances from the Negative or Positive Electrode.

(f) *Interrupted Galvanism,* in which the Current is mechanically interrupted or broken into a series of sharp Impulses, somewhat resembling a Primary Faradic Current.

11. *General Galvanization* is used by some practitioners in the treatment of Organic Spinal Disease, Obesity and Diabetes. Large Block-tin Electrodes are used, covered with Gauze, wet with Salt Solution; the Cathode being applied over the upper part of the Spine, and the Positive Electrode over the Abdomen. Twenty to fifty milliamperes are given, the duration of each treatment averaging twenty-five minutes.

12. *Local Galvanization* is employed in a variety of diseases, such as Neuralgia, Rheumatism, and acute and chronic Inflammation. In general, a small Sponge-covered Metal Disk Electrode is applied to the affected area, the Indifferent Electrode being of the usual type, described in paragraph 5. The choice of Poles depends upon the nature of the diseased

condition, the local effect of the *Positive Pole* being *sedative, hemostatic, germicidal* and tending to *relieve Congestion.* The *Negative Pole,* on the other hand, *produces Congestion, local Stimulation* and *Counter-irritation.*

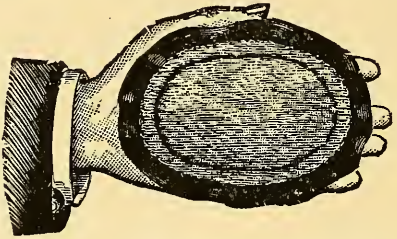

Fig. 31.—Flexible Hand Electrode.

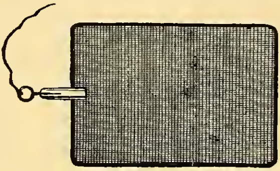

Fig. 32.—Flexible Wire Gauze Electrode.

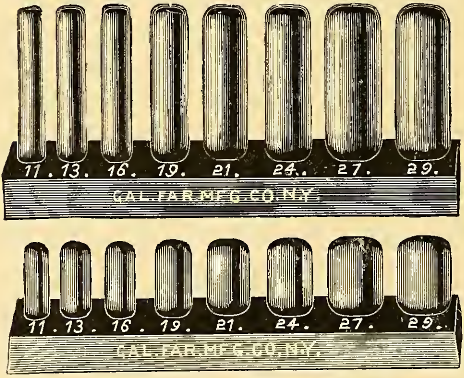

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Fig. 34.—Zinc and Copper Electrodes (*Soluble*), for Positive Electrolysis; with Rubber-covered Stem.

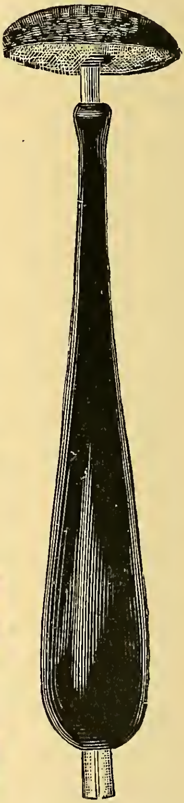


Fig. 33.—Sponge-covered Hand Electrode.

13. *Positive Electrolysis* is mainly employed in diseases of the Mucous Cavities, more particularly those of the Uterus and Vagina. Electrodes of Chemically Pure Zinc or Copper are employed; sets of different diameters are furnished, arranged to screw into a common Insulated Stem. Currents of from five to twenty milliamperes are used, the length of the treatment varying with the condition. The Acid Ions unite with the Metal of the Anode, forming Oxychlorides of Zinc or Copper, which are driven into the Mucous Membrane surrounding the Electrode. As this action causes *adhesion*, it will be necessary after turning off the Current, to turn it on again in the *opposite direction*, after which the electrode may be readily withdrawn.

14. *Negative Electrolysis* is a destructive process in which redundant or diseased tissues are softened and disintegrated by the Chemical action of "Caustic Soda" which collects around the Negative Electrode as a result of the Electrical Decomposition of the Sodium Chloride in the tissues of the Body. If a Galvanic Current be passed through a Solution

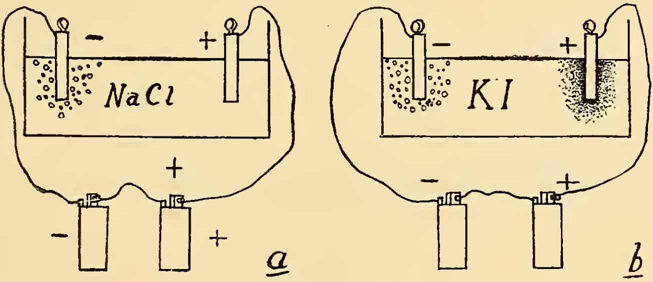


FIG. 35.—TESTS FOR POLARITY.
a, Sodium Chloride Solution with Hydrogen bubbles at Cathode.
b, Potassium Iodide Solution with Hydrogen at Cathode and Iodine at Anode.

of a Salt such as Sodium Chloride, the Chlorine, or Negative Ions of the latter will collect around the Positive Electrode, while the Sodium or Positive Ions appear at the Cathode. A Chemical Re-action will then occur in which an Atom of Sodium takes the place of an Atom of Hydrogen in a Molecule of Water; the result being Sodium Hydroxide, which dissolves in the solution and Hydrogen Gas which bubbles to the surface. If *Potassium Iodide* be used, the Iodine, which is liberated at the *Positive Pole* appears as a *dark brown cloud*. This re-action forms a convenient *Test for Polarity;* for example:—if we wish to determine the Poles of the Edison Electric Light Current, the two tips of the Conducting Wires are touched to the opposite sides of a drop of Potassium Iodide Solution, and the Positive terminal at once surrounds itself with a *brown cloud*, while fine white bubbles rise from the Negative Wire. The tissues of the Human Body are rich in Sodium Chloride, which also forms 0.6 per cent. of the Blood-serum and Lymph. When a Galvanic Current passes through the Body, the Sodium Hydroxide, or Caustic Soda,

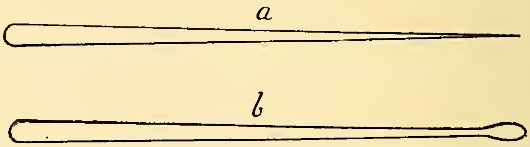


Fig. 36.—*a*, Sharp-pointed needle ("Broach") for moles and warts *b*, Bulb-tipped needle for removal of hair.

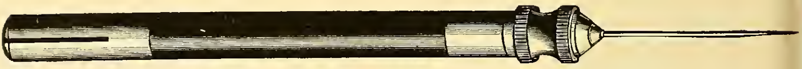


Fig. 37.—Needle holder for Negative Electrolysis.

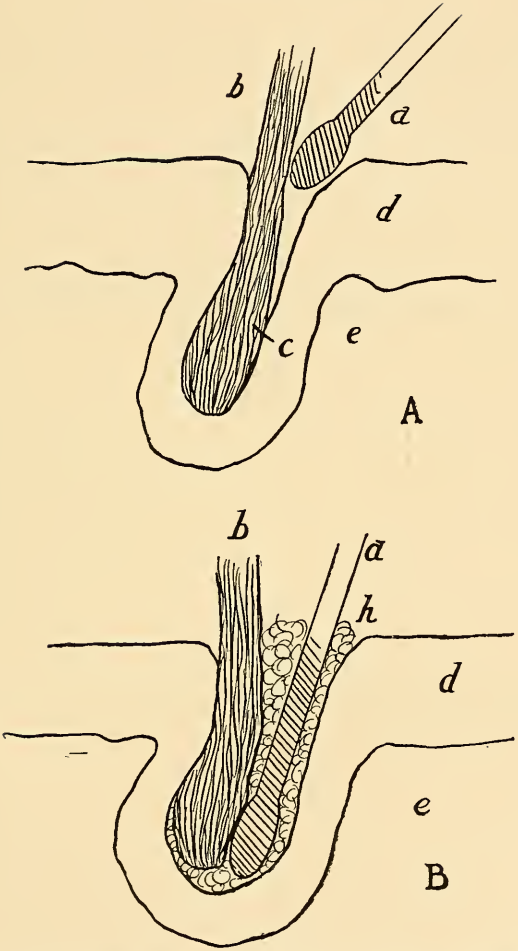


Fig. 38.—Electrolysis of Hair; Magnified 600 Diameters.

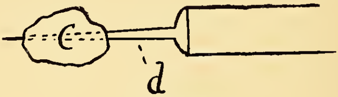
A. Bulb-tipped needle, (*a*) working its way into the follicle, (*b*) containing the hair-root, (*c*).

B. Needle, (*a*) in follicle, which is being converted into a soap-like débris, (*b*) mixed with Hydrogen bubbles.

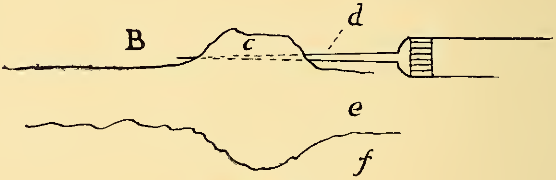
d—Epidermis. *e*—Dermis or true skin.

which collects at the Negative Electrode, will destroy the tissues in immediate contact with the latter, converting them into a soft soap-like material.

When this Process is applied for the removal of Superfluous Hair, the Cathode should consist of a fine steel Needle having a *rounded, bulb-like extremity* and fixed in an Insulated Holder. The Needle should be carefully slipped into the Follicle at the side of the Hair which is to be removed, using a Magnifying Glass if necessary. The Patient is then instructed to gradually bring the right hand into contact with a Sponge-covered Electrode, or to gradually immerse the fingers in a bowl of Salt Solution, which contains the Positive Electrode. From one to three milliamperes should be used, until a White Bubble, the size of a pin head, appears at the mouth of the Hair Follicle; the Patient is then instructed to break contact, or to slowly withdraw the fingers from the solution;



Top View.



Sectional View.

Fig. 39.—Electrolysis of a Wart or Mole.
c, Portion of the growth raised above the surface of skin. *d*, Sharp needle in holder, piercing the growth. *e*, Epidermis. *f*, True skin.

the Needle is then removed, and if the Operation has been successful, the Hair may be slid from the Follicle by means of a pair of forceps. If the Hair resists, it should not be pulled out, as the Follicle has been only partially destroyed. The Needle should be again inserted and the Current passed until the Hair is completely loosened from its attachments.

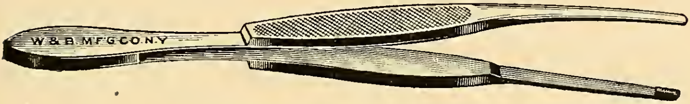


FIG. 40.—EPILATION FORCEPS.

From one-half to two minutes will be required for the destruction of each Hair according to its size and the character of the Follicle. It is unwise to remove all the Hairs from a small area at one sitting. It is safer to remove a few Hairs from each affected area.

For the removal of Warts, Moles, Birthmarks, etc., practically the same Technique is employed as in the destruction of Superfluous Hair, except that *Sharp-pointed Needles* are used. The Point of the Needle is inserted in the Growth near its base and pressed in until it almost emerges from the opposite side; the Needle will then be almost parallel with the surface of the Skin. A Sponge-covered Electrode, wet with Salt Solution, is held in the Hand of the Patient, and a Current of from two to fifteen milliamperes is gradually

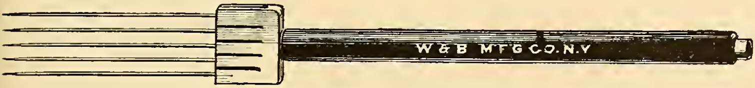


FIG. 41.—NEEDLE HOLDER FOR ELECTROLYSIS OF BIRTHMARKS; HEMORRHOIDS, ETC.

turned on. For small Growths not more than a quarter of an inch in diameter, not more than five milliamperes will be required. The Current is allowed to flow until the entire Growth acquires a white bleached appearance. This will be accomplished in from one-half to two minutes in the majority of cases. If the Growth be larger than the average, it may be necessary to repeat the Operation, the Needle being inserted at right angles to its first position. The application of Antiseptics, Cerates, etc., should be avoided, as the Growth usually shrivels into a Brown Scab, which falls off in the course of a week or two. Spirit of Camphor applied after the Operation will hasten the drying process. For the destruction of Birthmarks covering a considerable surface, an Electrode is used consisting of from three to six Needles fixed in a Clamp, forming a Row of Points about one-eighth inch apart. These are inserted to a depth of about one-eighth inch, and the Current turned on until the bleached area is formed around the Row of Points. The latter are then inserted parallel to their first position at such a distance that the second bleached area will just meet the edge of the first. This process is continued until the entire area of the Birthmark has been bleached. It is hardly necessary to state that the Current should be gradually shut off after each Operation, before removing the Needles.

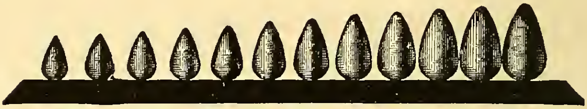


FIG. 42.—SET OF OLIVE TIPS FOR URETHRAL STRICTURE ARRANGED TO SCREW ON AN INSULATED STEM.

In the treatment of *Urethral Stricture* by Negative Electrolysis small Olive-shaped Metal Cathodes are employed, graduated and numbered according to their diameter, as is the case with Urethral "Sounds." They are sold in sets and arranged to screw on to the end of a slender Insulated Stem, which may be straight, curved or flexible. It is safer, although more expensive, to employ instead of the above outfit, a set of Olives, each of which is permanently fixed to a separate Insulated Stem. A Urethral Stricture is a circular Scar or Cicatricial Ring formed of dense Fibrous Connective-tissue, without Capillaries of Lymphatics, which partially occludes the Lumen of some portion of the Urethra. The internal diameter of the Stricture should first be ascertained by the passage of Sounds, great care being taken to avoid forcible dilatation. An Olive-tipped Cathode several sizes larger than the Lumen of the Stricture is carefully

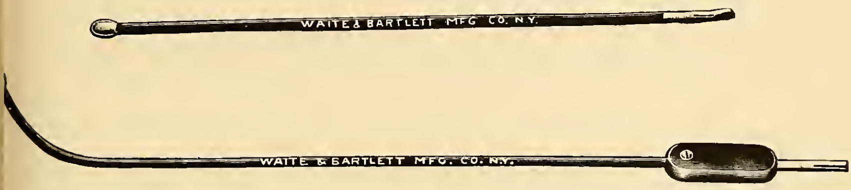

WAITE & BARTLETT MFG. CO. N.Y.
WAITE & BARTLETT MFG. CO. N.Y.

Fig. 43.—Straight and Curved Olive-tipped Electrodes for Electrolysis of Stricture of Urethra.

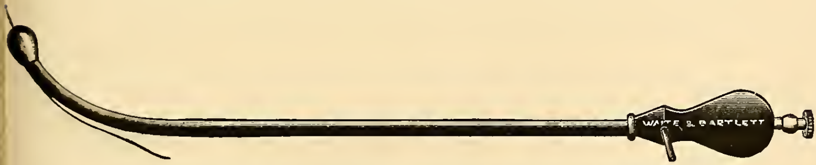


Fig. 44.—Channeled Electrode with Filiform Director, for Aggravated Cases of Stricture in which Pockets have Formed in the Urethra.

passed into the Urethra until its anterior portion is in contact with the Fibrous Ring. A large flat Anode, wet with salt solution, is placed over the Abdomen and the Current gradually turned on, while the Cathode is gently pressed against the Stricture. In from five to ten minutes the latter will have been softened so as to permit the Olive tips to pass completely through. On attempting to withdraw the Cathode, resistance will again be encountered, and it should be held against the under side of the Stricture until the Current renders its removal easy. With small Olives not more than five milliamperes should be used, while with medium or large Olives a maximum of ten or fifteen milliamperes, respectively, may be employed. When the Patient complains of severe pain or burning, it is an indication that too strong a Current is being used. Treatments should be given not oftener than once a week. At the first treatment only one size of Cathode is to be used. At the second treatment it will be found necessary to repeat the original procedure with

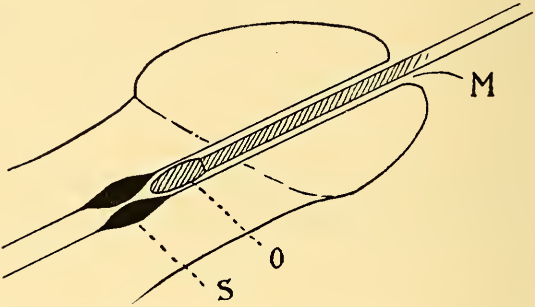


Fig. 45.—Method of Applying Electrode in Electrolysis of Stricture. (Shown in section).
M, Meatus Urinarius. *O*, Olive tip of Electrode. *S*, Cicatricial ring, which constitutes the Stricture.

the Olive first employed, after which the Operation is repeated with a Cathode of a slightly larger size. The reason for this procedure is that the Fibrous Ring slightly contracts during the interval between treatments, thereby reducing the Lumen of the Stricture. The treatments should be continued until the Fibrous Ring is practically obliterated, or until its Lumen remains of the same diameter as other portions of the Urethra. If carefully followed, a permanent cure will be obtained in almost every case. Where the Stricture is complicated by a Chronic Gleet, or Cystitis, it will be necessary to employ very mild Currents and avoid forcible dilatation. Many so-called failures result from the neglect of these precautions, as the slightest force on a chronically Inflamed Urethra will tear the Mucous Membrane, forming an Ulcer, which will in turn lead to the formation of another Stricture.

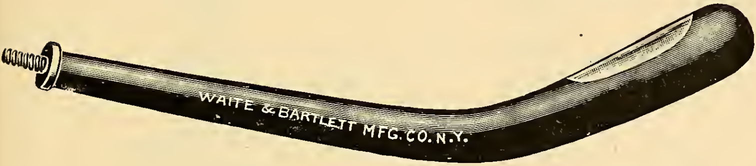


Fig. 46.—Electrode for Treating Enlarged Prostate, per Rectum.

Negative Electrolysis is also employed in the treatment of Enlarged Prostate, Uterine Fibroid, Hemorrhoids, etc. For the special Technique used in these different conditions, the reader is referred to more elaborate treatises on Electrotherapeutics.

15. *Cataphoresis*, or *Electrical Osmosis*, are synonymous terms applied to the process of driving Medicinal Substances into the tissues by means of Galvanism. It is based upon

the attraction and repulsion of *Ions* under the influence of an Electrical Current; substances being characterized as *Electro-positive* and *Electro-negative,* according to their action in reference to the Poles of a Galvanic circuit. Generally speaking, all Metals or Basic substances are Electro-positive; Acids, on the other hand, are Electro-negative. If we employ a solution of a Salt such as *Iodid of Lithium,* for example, we may drive either the *Iodin* or the *Lithium* into the tissues. If a Sponge-covered Electrode be soaked in a solution of the Salt, and connected to the *Positive Pole* of a Galvanic Battery, the *Lithium Ions* will be driven into the tissues; while if the Electrode is attached to the *Negative Pole,* the *Iodin* will be driven in. By bearing in mind the Polarity of the different Chemical Substances and observing the Law that "Bodies of like polarity mutually repel" while "those of unlike polarity mutually attract,"—the Physician will have no trouble in determining the particular Pole

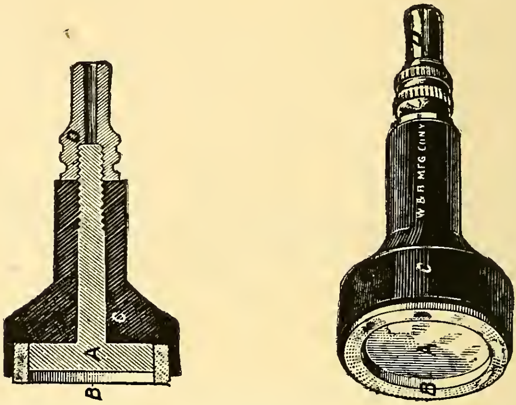


FIG. 47.—RESERVOIR ELECTRODE FOR CATAPHORESIS.

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which should be used to drive a given substance into the Body.

Electrical Osmosis is commonly employed,—with a solution of *Cocain* to produce *Local Anesthesia;* —with *Adrenalin,* to drive the Blood from the Capillaries, prior to Operation or application of the *Ultra-Violet Ray;*—with *Salts of Lithium,* or *Salicylic Acid* in the treatment of *Gout;*—with *Iodin* or its *Salts,* in the treatment of *Goitre* and *Syphilitic Lesions;*—with *Chloroform* or *Tincture of Aconite,* in *Facial Neuralgia;*—and with *Metallic Mercury,* for the *destruction of Malignant Tumors,* according to the method of Doctor Massey.

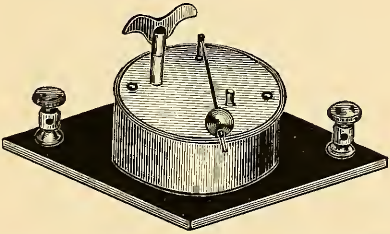

FIG. 48.—ELECTRIC METRONOME OR RHEOTOME FOR MECHANICALLY INTERRUPTING A CURRENT.

16. *Interrupted Galvanism,* or the use of the Galvanic Current mechanically interrupted, or broken into a series of *Periodic Impulses,* is closely allied to the Primary Current from a Faradic Coil. It will be fully discussed in the Chapter on *Electro-diagnosis.*

CHAPTER V

FARADISM

1. *Faradism*, as stated in a previous Chapter, is a term applied to the Interrupted Currents obtained from the Secondary Circuit of an Induction Coil. Electrically speaking, it is an *Induced, Unsymmetrical, Alternating, Interrupted Current*, of *relatively High Voltage* and *Low Amperage;* the Potential varying from 1,000 to 50,000 Volts, and the Volume, from One one-thousandth,—to One milliampere, according to the size and length of the Secondary Coil.

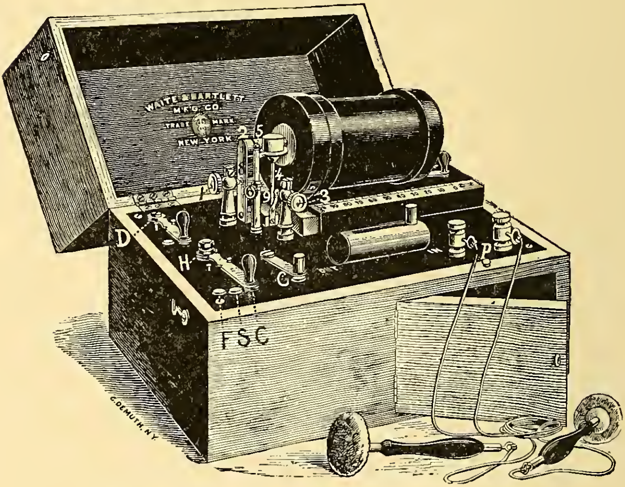

FIG. 49.—HIGH TENSION FARADIC APPARATUS.

2. A good Faradic Outfit should consist of a Soft-iron Core, wound with several layers of medium sized Wire, so arranged as to permit of the use of two or more Secondary Coils, which are slipped over the Primary to a greater or less degree, according to the strength of the Current desired. One of these Secondaries should consist of a comparatively *few layers* of relatively *coarse Wire*. Another should have a *considerable number of layers* of *fine Wire*. If possible, a third Secondary should be obtained, wound with *at least a half-a-mile* of *very fine Wire;* the three Secondaries being conveniently referred to, as the "*Low*," "*Medium*," and "*High Tension Coils*." The Outfit should be provided with both a Slow and a Rapid Interruptor, the latter being preferably of the "Ribbon" type, consisting of a thin Strip of Steel stretched between two Posts, one of which is provided with

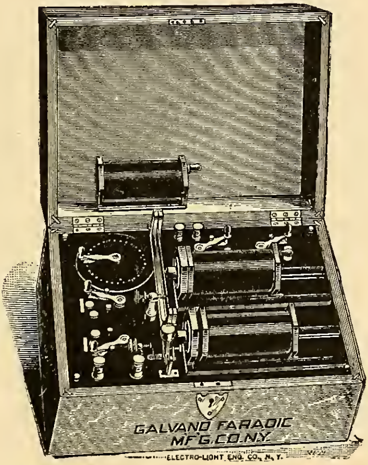

FIG. 50.—HIGH AND LOW TENSION FARADIC APPARATUS.

a Screw for adjusting the tension of the Steel Ribbon. The Coarse or Slow Interruptor should be adjustable so as to give a range of from *two* to *ten breaks per second,* while the Rapid Interruptor should give from *fifteen* to *four hundred breaks per second.*

3. The terms "*Unsymmetrical,*" "*Alternating*" and "*Interrupted*" have been applied to the Faradic Current:—

It is "*Interrupted,*" because the different Impulses are separated by Intervals, during which no Current passes.

It is "*Alternating,*" because the Impulse induced when the *Core becomes Magnetic* is in opposite direction to the Impulse induced when the *Core loses its Magnetism.*

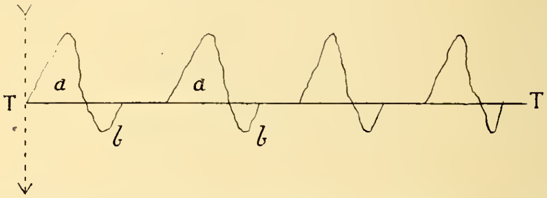

FIG. 51.—CURVE, OR "GRAPHIC TRACING" OF A FARADIC CURRENT. *a a,* The impulses induced by the Primary "Break." *b b,* The impulses induced by the Primary "Make." *T T,* Abscissa, or Time Line. *V V,* Ordinate, or Voltage Line.

It is "*Unsymmetrical,*" because the Impulse produced by the *closure,* or "*make,*" is less than the Impulse which follows the "*break,*" or *opening,* of the Primary Circuit.

4. Large Induction Coils of the *Ruhmkorff* type consume a considerable Volume of Current in the Primary Circuit and are usually excited by Storage Batteries, or the Continuous Electric Light Current. The latter may also be used for the operation of Faradic Coils by placing a 16 Candle-power Incandescent Light in series with the Primary Coil and Interruptor.

It is usually more convenient to employ the ordinary Dry-cell Batteries, two to four of which will be sufficient for the operation of the majority of Faradic Coils.

5. The Physiological effect of a Faradic Current depends largely upon its Voltage and the Frequency of Interruption. A Current of Low Voltage and Slow Interruption acts principally on the Muscles and the Motor Nerves, producing "*Intermittent*" or "*Clonic*" *Muscular Contractions;* while a Current of the same Voltage but of Higher Frequency produces a Continuous Contraction, technically known as a state of "*Tetanus,*" or "*Tonic Spasm.*"

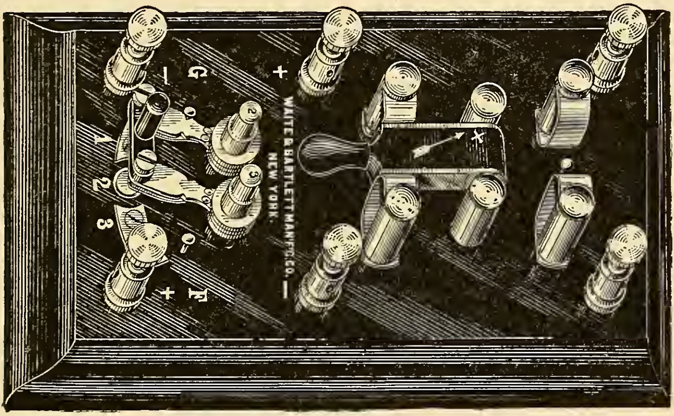

FIG. 52.—SWITCH FOR THE PRODUCTION OF THE COMBINED GALVANIC AND FARADIC, OR "THE DE WATTEVILLE CURRENT."

A Faradic Current from a High-tension Secondary should be of a High Frequency, such as is produced when the Ribbon Vibrator emits a *Musical Note.* A Current of this character is of great value in the treatment of Neuralgia, Sciatica, and other forms of Acute Pain, except those associated with

Inflammation or Septic Infection. The Low-tension Faradic with Slow Interruption is used therapeutically to promote Muscular Growth, to relieve Stiffness due to Rheumatism, or following an Injury, to promote the absorption of Exudates, Gouty Deposits, etc.; and for the production of Muscular Contractions, as a form of Passive Exercise, in cases of Partial Paralysis, Muscular Atrophy, etc. If used with the Rapid Interruptor, the Low Tension Faradic may produce results of quite an opposite character, exhausting and depleting rather than invigorating the Muscles. The Medium-tension Faradic Current may be used with either Slow or Fast Interruptor, as a means of stimulating Circulation, and relieving Congestive Headaches. *It should be used, however, only when a true High-Frequency Current is not available.*

6. By a mechanical device called a "*Rheotome,*" or "*Electrical Metronome,*" a Galvanic Current may be interrupted periodically, the resulting Current closely resembling that from a Low-Frequency, Low-Tension Faradic Coil, except that the Impulses are all in the same direction. It is used for practically the same purpose as the latter. If a Faradic Current of Medium-Tension with moderately Rapid Interruption be connected in Series with a Galvanic Current, we have what is known as a "*Galvano-Faradic,*" or *Combined Current,* often called the "*Watteville Current.*" This Current has been used with some success in the treatment of Constipation, Enlarged Prostate, etc.

CHAPTER VI

ELECTRO-DIAGNOSIS

1. The manner in which Muscles react to Electrical Impulses in a healthy Organism differs from the reaction of Diseased or Degenerating Muscles and Nerves. *Electro-diagnosis* is based upon the above proposition.

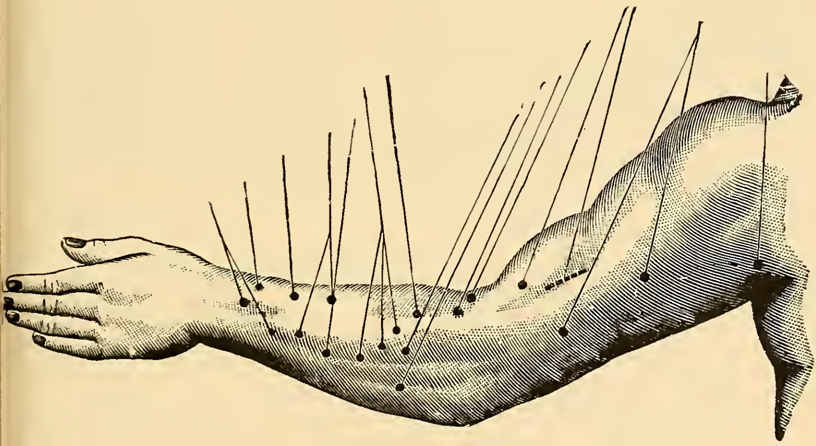

FIG. 53.—MOTOR POINTS.

2. In testing for Degeneration in Nerves or Muscles, a small Sponge-covered Electrode is used, which is applied to certain areas called "*Motor Points;*" each of which corresponds to a particular Nerve or Muscle. A large Indifferent Electrode is usually applied to the Abdomen. A Slowly

Interrupted Galvanic Current and a Moderately Rapid Faradic Current, of Medium-Tension are used in making the tests.

3. As Degeneration is almost invariably *unilateral,* it is customary to test corresponding Muscles alternately on the right and left side, as in this way the difference in reaction between a Normal and a Degenerated Nerve is readily demonstrated.

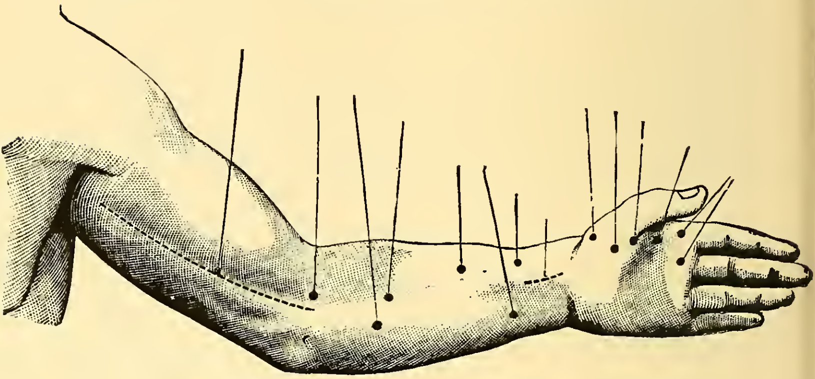

FIG. 54.—MOTOR POINTS.

4. When the Cathode is applied to the Motor Point of a healthy Nerve or Muscle, and a Slowly-interrupted Galvanic Current is gradually turned on, a point will be reached at which the Muscle will *contract* at each *Closure* of the *Circuit.* This is called the "*Cathode Closure Contraction.*" If the Polarity of the Electrodes be now reversed, it will be found necessary to increase the strength of the Current before the Muscle will contract,—as in the first instance,—at each Closure of the Circuit. This second Contraction is called the "*Anode Closure Contraction.*" If the Current be again increased we obtain a Contraction at each "*Break*" as well

as at each *Closure* of the Circuit; in other words, an "*Anode Opening Contraction.*" To produce a "*Cathode Opening Contraction*" in a Normal Muscle requires a Stronger Current than most Patients can bear.

5. In well-marked Degeneration of a Nerve, the above order is *reversed,* the *Anode Closure Contraction* being manifested by a *weaker Current* than that necessary for the production of a Contraction at *Cathode Closure.* In extreme or complete Degeneration, the Contraction either does not occur at all,—or follows sluggishly and with an interval between the *Anode Closure* and the *Muscular Impulse.* In many conditions which involve Nerve Degeneration, the Muscle does not contract under the influence of the *Faradic Current.* In less severe conditions, the Contraction requires a Strong Current and occurs only after an appreciable interval. For the Differential Electrical Diagnosis of the various forms of Degeneration, the reader is referred to the Standard Text Books on Nervous Diseases.

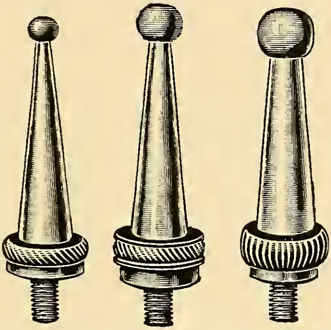

FIG. 55.—MOTOR POINT ELECTRODES FOR ELECTRO-DIAGNOSIS.

CHAPTER VII

STATIC ELECTRICITY

1. So-called *"Static" Electricity* is usually derived through Electrical Induction between revolving glass plates and charged areas fixed to stationary glass plates. The *"Holtz Machine"* exemplifies this principle and is the most popular form of Static Apparatus among American Physicians. In Europe, the *"Wimshurst Machine"* is more generally em-

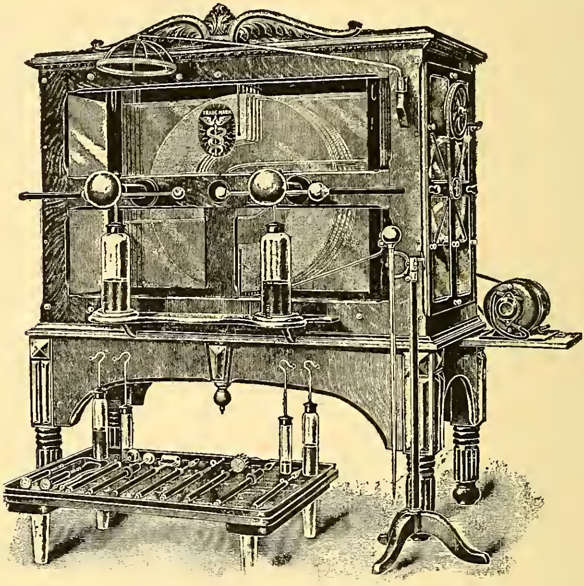

FIG. 56.—MODERN HOLTZ MACHINE.

ployed. It generates its Currents through the mutual Induction of parallel glass or rubber plates, revolving in opposite directions. Its *initial charge* is obtained by the friction of small Tinsel Brushes against the revolving plates. It possesses certain advantages over the Holtz Machine, in that it is less sensitive to moisture and is self-charging, while the Holtz Machine must be given an initial charge before it can generate a Current. This is usually accomplished by the use of a small Wimshurst Machine, mounted in the end of the case containing the larger Apparatus. A number of Western Manufacturers have introduced Static Machines of the so-called "*Toepler-Holtz*" type. They differ from Holtz Machines in that they are self-charging, by the use of Tinsel Brushes, as in the "Wimshurst."

2. The Current from a Static Machine is *Continuous, Unidirectional,* of *great Voltage* and *extremely small Amperage.* In Therapeutic Machines, the Current will average between 10,000 and 100,000 Volts, and the Volume, from One one-thousandth to Two milliamperes. ($\frac{1}{1000}$ ma. to 2 ma.). The greater the *number* of revolving plates, the greater will be the *Amperage.* The greater the *diameter* of the plates, the greater will be the *Voltage.*

3. The *Static Discharge* between the metal Balls which form the Terminals of most Machines, appears as a zig-zag Spark, with the thicker, brighter portion next to the *Positive Terminal.* It appears, and is in reality *a perfect miniature reproduction of a Flash of Lightning.* If the Terminals be too far apart for the Spark Discharge, the Current will still appear as a Violet Brush Discharge called an "*Effluve.*" If the Terminals be still further separated, no actual Current will pass between them, but the Electricity will discharge into the air from the Positive Pole in the form of a Purple Brush or "*Aigrette;*" and at the Negative Pole, in the form

of a number of brilliant *Points.* If the Terminals be approached within sparking distance, and a Metal Ball-tipped Electrode, connected with the *ground* be brought near the *Positive Pole,* the Spark will be *diverted* to the *Earth* and cease to flow between the Terminals; but if the Electrode be brought near the *Negative Terminal,* the Spark will *continue to flow between the Poles.* The Static Discharge tends to the form of *Sparks* between *Spherical Surfaces,* and forms an "*Effluve*" between *Metal Points,* or *Sharp Edges.*

If a *Leyden Jar* be attached to each Terminal of a Static Machine, and the two outer coatings be connected by a rod or wire, the Spark between the Terminals will be made *longer, brighter, louder* and *less frequent.* Increasing the size of the Leyden Jars increases the degree of each of the above qualifications.

4. For the Therapeutic administration of Static Electricity, a large *Platform* should be provided, supported by insulating glass legs, not less than six inches long. The Patient either sits in a chair upon the *Platform* or stands upon a *Metal Plate* placed upon the Platform and connected to one Pole of the Static Machine by a Rod or Chain. When sitting in a chair the metal Rod or Chain is held in the Patient's hand. Various Electrodes should be provided, including a *Small,* and a *Large Metal Ball,* and a *Single,* and Multiple Metal Point Electrode;—each being provided with an insulating Handle of Wood or Hard Rubber. A *Metal Roller Electrode* is also desirable; also four *Metal Disk Electrodes,* two of which should be *Sponge-* or *Felt-covered,* like those used in Faradism. An uninsulated *Metal Point Electrode,* and a wire "*Fly Brush,*" with insulated Handle are desirable. Various forms of "*Vacuum Electrodes*" are employed with the Static Machine but they should be properly restricted to the application of *High-Frequency Currents.*

5. Static Electricity is applied in Therapeutics in a number of distinct modifications, or "*Modalities,*" as follows:

(a) "*Static Insulation*" or the "*Static Bath.*"
(b) The "*Static Breeze.*"
(c) The "*Static Effluve*" or "*Brush Discharge.*"
(d) Direct, or Indirect "*Static Sparks.*"
(e) The "*Static Induced Current.*"
(f) The "*Morton Wave Current.*"

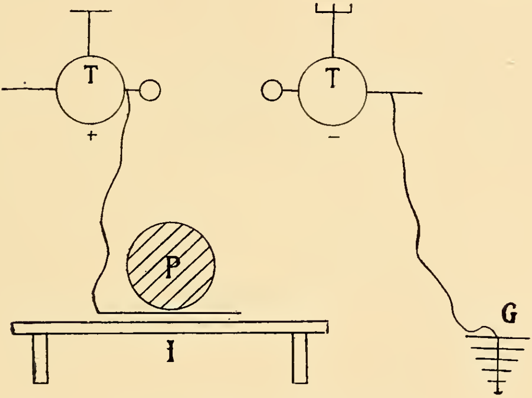

Fig. 57.—Static Insulation.
T T, Terminals of Static Machine. *I*, Insulating Platform. *P*, Patient. *G*, Ground Connection.

6. The *Static Bath* is spoken of as *Positive* and *Negative Electrification,* according to the Polarity of the Terminal to which the Patient is connected. The latter sits in a chair on the platform, being connected to one Terminal of the Machine by the metal Rod or Foot-Plate; and the opposite Terminal is connected to the *Earth* by means of a wire attached to a Water- or Steam-pipe. A soothing, restful effect is produced on the Patient, especially if he be connected to the

Positive Pole. This method is of value in the treatment of Insomnia, Hysteria and Reflex Nervous conditions.

7. *Static Breeze* is administered by the use of a Metal- or Carbon-point Electrode, suspended over the Patient's head, or held about a foot away from any part of the Body which it is desired to treat. The Electrode is connected to the Positive Pole which is also grounded. The Patient is seated on the Platform and connected with the Negative Pole. This Modality is of service in the treatment of Headache, local Congestion of Nervous origin, and in Neuroses. By reversing the Poles with the above arrangement, a Negative Static Breeze is obtained, but the first method is preferred as it causes less irritation.

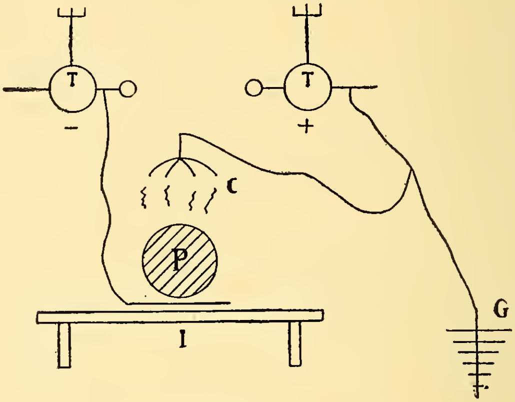

FIG. 58.—STATIC BREEZE.
C, "Canopy," or "Umbrella" Electrode.

8. The *Static "Effluve,"* or *Brush Discharge* is obtained by the method just described, except that the pointed Electrode is held at a shorter distance from the Body. The

effects are more intensely stimulating than with the Breeze, and the method is employed for the relief of a variety of conditions, such as Rheumatism, Neuralgia, Spinal Irritation, and local Congestion of a superficial nature.

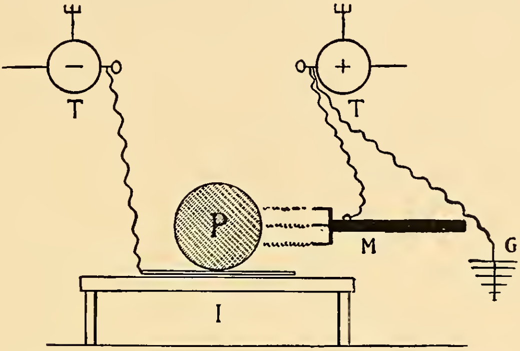

FIG. 59.—STATIC "EFFLUVE," OR "BRUSH DISCHARGE."
M, Metal Point Electrode.

9. The *Static Spark* is usually applied *indirectly*, by means of an insulated Metal Ball Electrode, attached to which is a chain with its opposite end in contact with the floor. The Patient is connected as for "*Positive Electrification*," and the Sparks applied through the clothing by carefully approaching the affected area with the Electrode. A *sharp Muscular Contraction* is produced by *each Spark*, especially when it is applied to a *Motor Point*. Sparks may be rendered less painful by holding a small Metal Ball Electrode in contact with the Skin over the affected area, and allowing the Spark to pass between this Electrode and the one which is connected to the floor by the chain. The Direct Spark is applied by means of an Electrode connected to one Terminal of the Machine, no connection being made with the other Terminal,

and the Patient in an ordinary, uninsulated chair. The latter method is not recommended, but is sometimes employed in the treatment of Motor and Sensory Paralysis. Indirect sparks are used in the treatment of Muscular Rheumatism, Partial Paralysis, Spinal Disease, Acute Neuralgic Pain, and Constipation resulting from Muscular Atony.

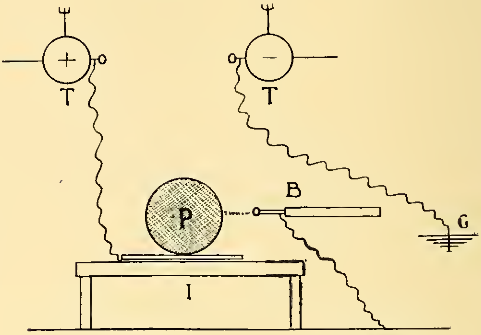

FIG. 60.—STATIC SPARK. (INDIRECT.)
B, Metal Ball Electrode.

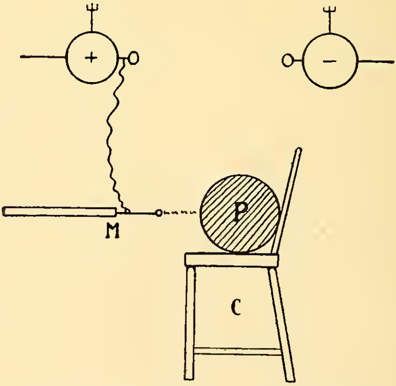

FIG. 61.—STATIC SPARK. (DIRECT.)
M, Small Metal Ball Electrode. *C*, Uninsulated Chair for Patient.

10. The *Static Induced Current* was introduced by Dr. W. J. Morton in 1881. It is applied to the surface of the Body by means of two wet Sponge-covered Electrodes, connected respectively to the outer coatings of two Leyden Jars, each of which is attached to a Terminal of the Static Machine. In the Static Modalities thus far considered, the sliding Terminal Rods are *withdrawn* so that no discharge can pass between them. In the Static Induced Current the Machine is started with the two sliding Rods in *contact*, and they are then *gradually separated* until the Patient complains that the Current is unpleasantly strong. In a few moments a toleration will be established, so that the Current can be borne without discomfort. This Modality may be used as a substitute for the *Faradic Current*, the Low-tension effects being obtained

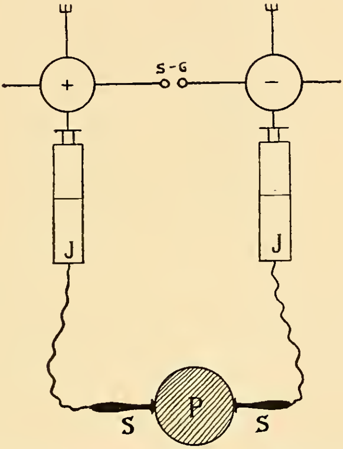

FIG. 62.—MORTON STATIC INDUCED CURRENT.
G, Spark Gap. *J J*, Leyden Jars. *S S*, Sponge Electrodes. *P*, Patient.

by the use of *large* Leyden Jars, while *small* Jars produce a Current similar to that from a High-tension Secondary Coil. It is used in the treatment of the same conditions that would be benefited by *Faradism,* and is also of value in relieving Stasis and stimulating sluggish Metabolism.

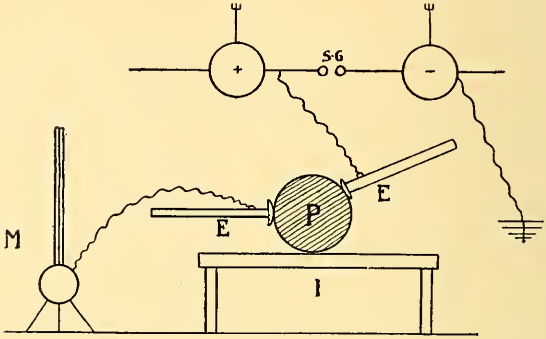

Fig. 63.—Morton Wave Current.

S G, Spark Gap. *E E,* Sponge Electrodes. *M,* Metal Stand. *P,* Patient.

11. The *Morton Wave Current* was first described by its Inventor in 1899, and is without doubt the most important of all Static Modalities. The Negative Terminal is *grounded,* and a Metal Disk Electrode, connected to the Positive Terminal, is placed in contact with the affected area of the Patient's Body. The Patient sits or stands on the insulated Platform and the Current is administered by gradually separating the Terminals, which should be in contact when the Machine is started, the same as with the "Static Induced Current." If desired, a second Metal Electrode, connected to an *insulated object,*—such as a metal Tube-stand,—may be applied to some indifferent portion of the Body. Generally

speaking, the Current increases Matabolism, stimulates the Circulation and the Secretions, promotes the appetite and increases Elimination. It is indicated locally for the relief of Pain, for the increase of Muscular Growth and Activity, and for the dispersion of Congestion, Inflammatory Exudates, and Gouty and Rheumatic Deposits. It is *contra-indicated* in *Acute Septic Conditions*, involving local Congestion and Pus-formation. In common with all other Static and Faradic Modalities, it should be *avoided* in the treatment of Organic Heart Disease; the *true High-Frequency Current* being the only form of Electricity which may be safely employed in the latter condition.

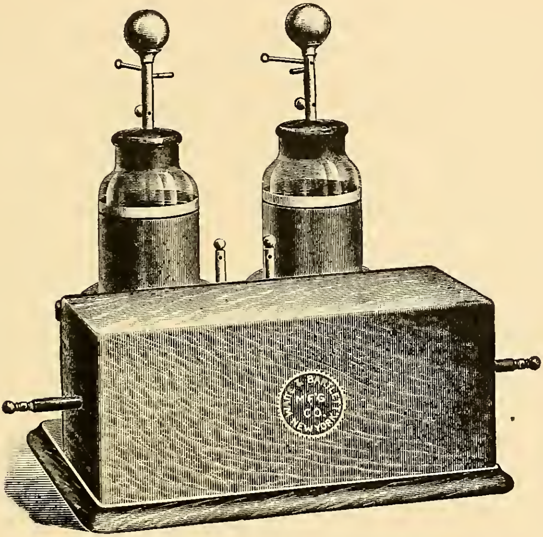
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FIG. 64.—DR. PIFFARD'S HYPERSTATIC TRANSFORMER.

CHAPTER VIII

HIGH-FREQUENCY CURRENTS

1. About the year 1890, Professor d'Arsonval of Paris conducted a series of experiments with Alternating Currents of different Frequencies. He employed a Mechanical Alternator consisting of a revolving Drum carrying a number of Electro-magnets on its periphery, rotating inside of a Ring of laminated iron, having a number of Internal Projections corresponding to the number of Electro-magnets on the Drum. A series of Coils wound upon the iron Projections were excited by a Direct Current from a Battery or Dynamo, and by revolving the Drum at different speeds, Sinusoidal Alternating Currents of different Frequencies were induced in the revolving Coils.

2. With an Apparatus of this description, d'Arsonval made a number of tests to determine the relation of Frequency to Sensory and Motor Nerve Reaction. He found that a Current alternating less than 15 times per second produced a succession of separate, or "Clonic" Muscular Contractions. A Frequency of from 20 to 30 per second produced a Continuous Contraction, in other words, a "*Tetanus*," or "*Tonic Spasm.*" Increasing the Frequency beyond this point increases the Tetanus. At about 3,000 Alternations per second the maximum intensity is reached, and a further increase of Frequency causes a decrease in the strength of the Contractions, until at a Frequency of 10,000 per second,

absolutely no effect is produced upon either the Motor or Sensory Nerves.

3. A Current, therefore, which alternates or oscillates 10,000 or more times per second is called, from a Therapeutic standpoint,—a "*High-Frequency Current.*"

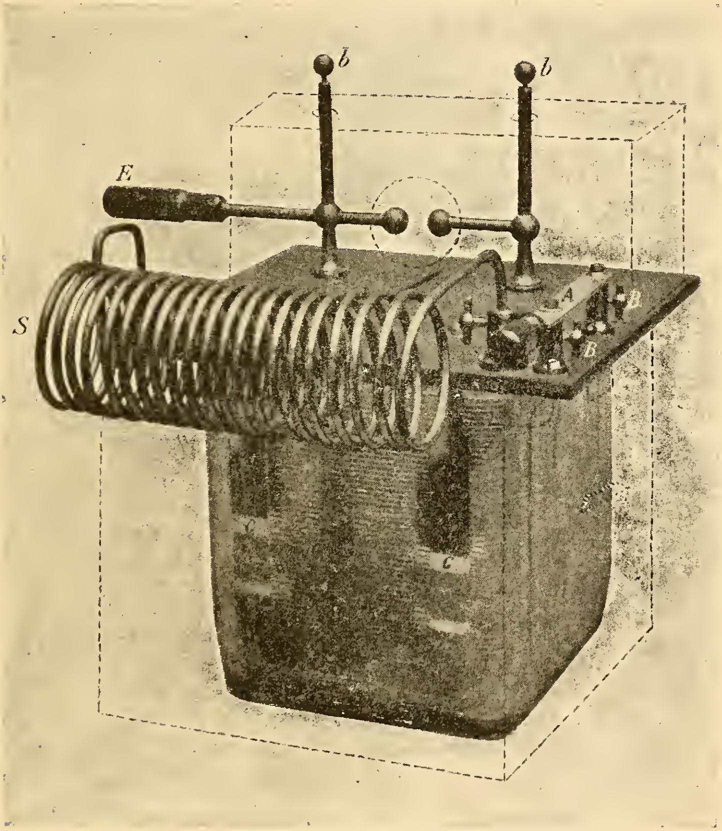

Fig. 65.—Heavy Solenoid with Oil Condenser.

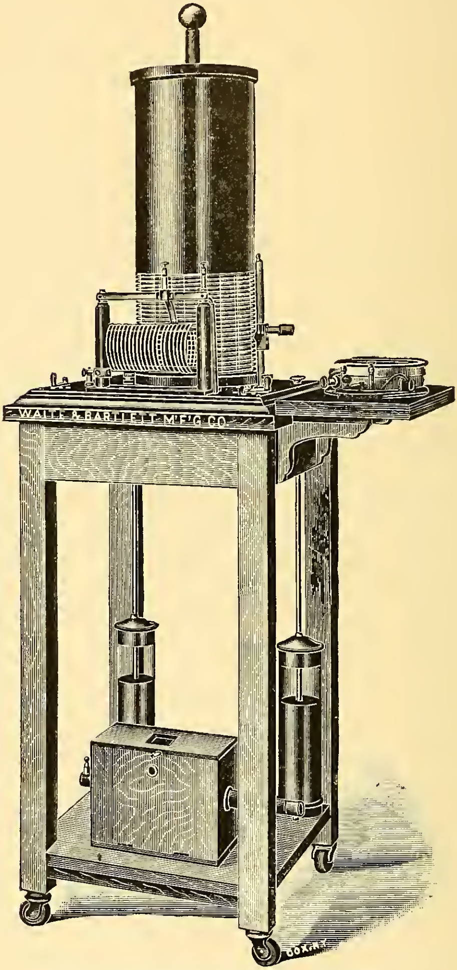
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Fig. 66.—Resonator and Solenoid.

4. At the present time three forms of High-Frequency Currents are employed in Therapeutics, namely:—

(a) The "*Solenoid Currents*" of d'Arsonval, introduced to the Profession about 1893.

(b) The "*Resonator Discharge*," developed by Oudin and presented to the Profession about 1896.

(c) The "*Tesla-Thompson Currents*" first employed therapeutically by the present writer in 1896.

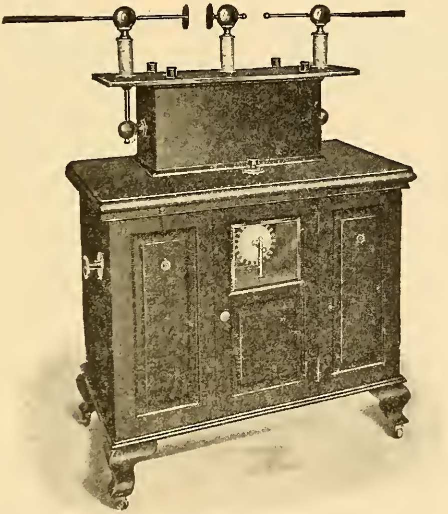

FIG. 67.—DR. STRONG'S HIGH-FREQUENCY APPARATUS.

5. Among the European Physicians, the d'Arsonval and Oudin Currents are principally employed, being obtained from an Apparatus consisting of a "*Resonator*" combined with a d'Arsonval "*Solenoid*," an adjustable *Spark-gap* and a pair of *Condensers* of the *Leyden Jar Type*. This Apparatus

is usually excited by the Secondary Current from a Ruhmkorff X-ray coil, but a Static Machine may be employed provided it has a sufficiently large number of revolving plates to furnish the required Amperage.

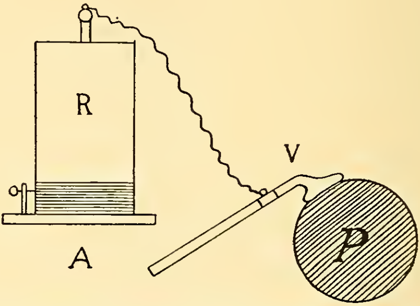

Fig. 68.—*A*, Direct Application of Resonator Discharge with Vacuum Electrode.

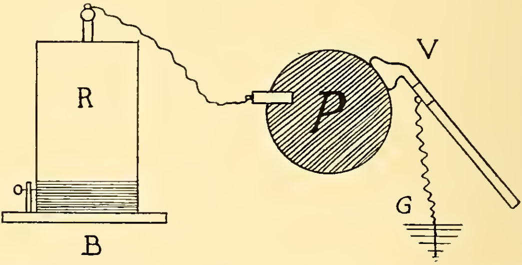

Fig. 69.—*B*, Indirect Application with Metal Hand Electrode and Grounded Vacuum Electrode.

6. The Current from the *Oudin Resonator*, which is Unipolar, of High Voltage and High-Frequency, is applied to the Patient by means of a rubber-covered Wire, connecting the Terminal of the Resonator to a glass or metal Electrode, provided with an insulating Handle; or the Patient may be con-

nected directly to the Wire from the Resonator, by a metal Hand-Electrode and the Current *drawn off* from some other portion of the body by means of a *grounded Electrode,* applied by the Operator. To obtain the maximum effect in the latter case, the Apparatus should be "*Tuned*" in accordance with the Capacity of the Patient's body by cutting out one or more turns of the Solenoid Coil. This is accomplished in a number of different ways.

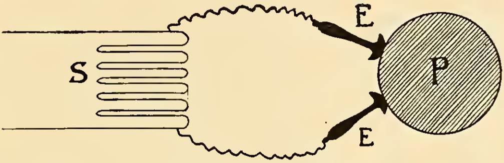

FIG. 70.—DIRECT APPLICATION OF D'ARSONVAL SOLENOID CURRENT. *S,* Solenoid. *E E,* Sponge Electrodes. *P,* Patient.

7. The Current derived from a d'Arsonval Solenoid is *Bi-polar,* of *High-Frequency,*—of relatively *High Amperage,* and moderately *High Voltage.* It is employed therapeutically in two ways:—

(a) *Direct Application* by means of two Sponge-covered Metal Disk Electrodes connected to the two Terminals of the Solenoid. A Hot Wire Mil-ammeter is in series with the Patient to measure the strength of the Current.

(b) *Indirect Methods,* including (I.) "*Auto-Condensation*" and (II.) "*Auto-Conduction.*"

(I.) In the first of these methods a so-called "*Condenser Couch*" is employed, consisting of a reclining Chair upon which is placed a thick rubber-covered Cushion, upon which the Patient reclines. The latter is connected to one end of the Solenoid by means of a Hand Electrode, the other Terminal being connected to a plate of Tin, or Zinc which is placed between the Chair and the under surface of the Cushion. The latter is thus made to play the part of the *insulating plate* of a Condenser, analogous to the *glass* of a Leyden Jar,—the inner and outer coatings of which are respectively represented by the sheet of Zinc, and the Body of the Patient.

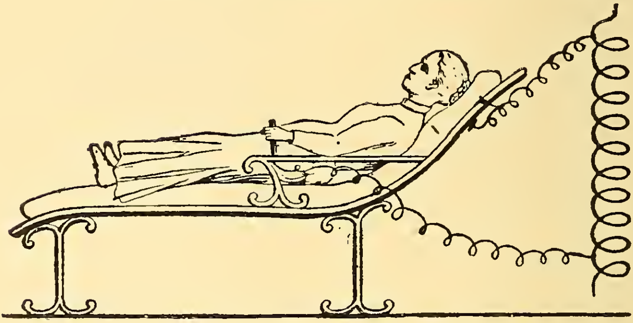

Fig. 71.—Auto-Condensation Couch.

(11.) "Auto-Conduction" is seldom used in this country, as the Condenser Couch produces practically the same results. In the application of High-Frequency Currents by Auto-conduction, a large Wire Spiral, wound in the form of a vertical or horizontal *Cage*, is connected to the outer coatings of the two Leyden Jars in place of the small Solenoid, the Patient standing or reclining inside the Cage, and forming a Secondary Circuit; High-Frequency Currents being induced directly in the tissues of the Body.

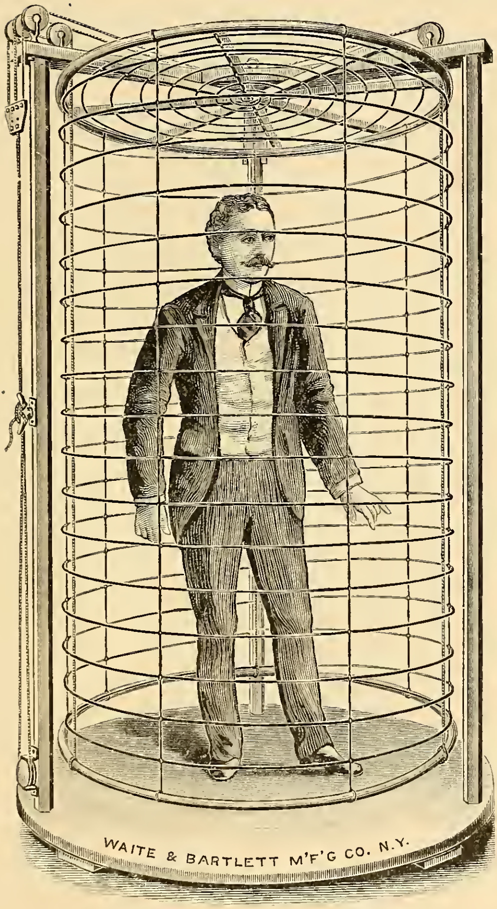
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FIG. 72.—AUTO-CONDUCTION CAGE.

(c) In America the Tesla-Thompson High-Frequency Currents are more generally employed than those of Oudin and d'Arsonval; the Apparatus and Technique for their Therapeutic use having been designed by the present writer.

Several forms of Apparatus for the production of Therapeutic Tesla Currents are shown in the annexed illustrations. They are designed primarily for use with the 104-Volt, 60-cycle, Alternating Current, but may be employed on a Direct Current circuit by the use of a "*Rotary Converter.*" The latter consists of a Direct Current Motor, provided with a pair of insulated Collector Rings which are connected respectively to opposite points in the Armature winding. A portion of the 110-Volt Direct Current which excites the converter, causes the rapid revolution of the Armature as in an ordinary motor, the remainder passes from the Armature Coil to brushes bearing on the Collector Rings forming an alternating current of about 80 Volts and of a Frequency corresponding to the number of revolutions per minute of the Armature shaft. The Current thus produced will operate any of the writer's High-Frequency Machines as well as the Commercial Alternating Current, except that a smaller "*Choke Coil*" must be used on account of the difference in Voltage of the two Circuits.

8. The Currents obtained from the Terminals of the writer's Apparatus have a frequency of from one- to two-hundred-thousand per second, and a Voltage averaging perhaps five-hundred-thousand. By employing a single Terminal of the Apparatus, a *Uni-polar Discharge* may be obtained, practically identical with that from an *Oudin Resonator*, while if both Poles be employed *Bi-polar Currents* of great Volume and Intensity will be obtained.

9. The physical properties of the Current may be studied

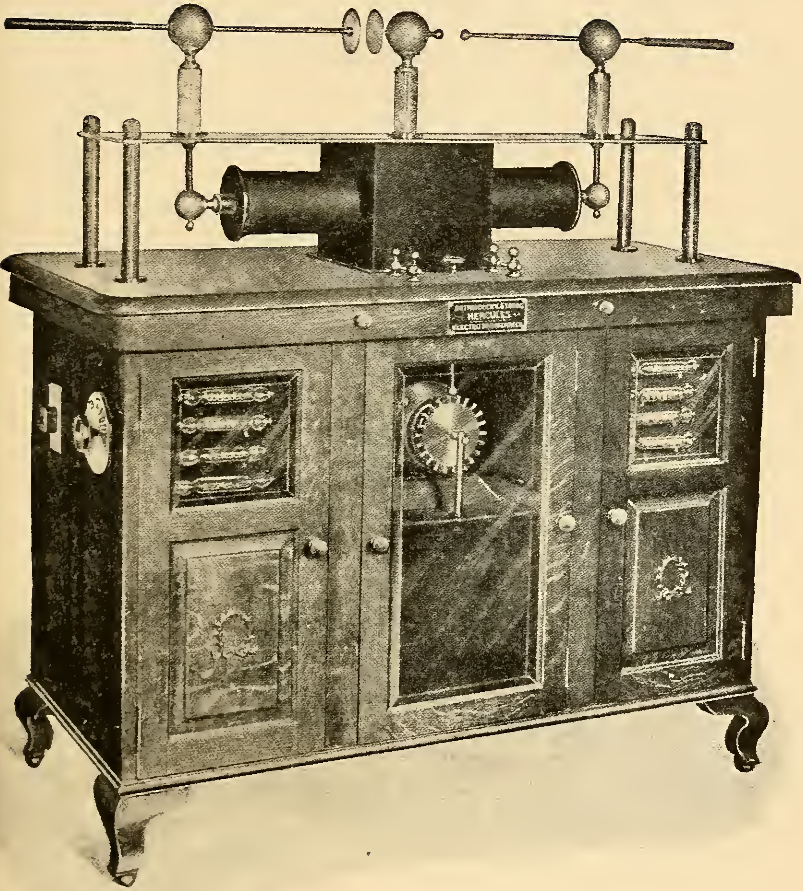

FIG. 73.—DR. STRONG'S "HERCULES" HIGH-FREQUENCY APPARATUS.

by manipulating the Triple Terminals with which all of the writer's Machines are provided. By pushing in the handle of the right and left Terminals, a circuit will be formed through the insulated Center Terminal, which is called a "*Dummy;*" by pulling out the right-hand Sliding Rod, while the Machine is in operation, the Current will discharge in the form of a flaming "*Arc,*" or Pencil of Light, of an apparently continuous character between the small Brass Balls of the Terminal Rod and the "Dummy." This Arc is a true *Electric Flame,* and will light a Candle or Stick of Wood in the same way as a Gas Flame. Its intense heat is shown by the combustion of a piece of fine *Iron Wire* when held in a pair of forceps near the right-hand Terminal Ball. If the Arc be viewed in a tilting Mirror, it will be broken up into a series of groups, each formed of a number of distinct Arcs separated by dark spaces. By making the Spark-gap as wide as possible, the Arc is changed to a *Spark-like Discharge,* which the writer has termed the "*Pseudo-static spark.*" By pushing the two Terminal Balls together, and separating the Disks, a beautiful purple *Effluve* will be formed, composed of hundreds of fine thread-like purple Sparks. This Effluve is made up of alternating streams of *Positive Ions* moving at a high rate of speed. By placing a perfectly flat Card or Photograph Mount in close contact with one of the Disks, the Ions will be prevented from discharging on that side, and the force of the Ionic bombardment from the opposite Disk will be sufficient to support the Card in its position, and a considerable effort will be necessary in order to remove it. If the Disks be pushed into contact and a piece of Plate Glass interposed between the small Balls, the Discharge will spread out on either side of the Glass forming a beautiful "*Rosette*" of radiating Sparks. If allowed to continue, the Discharge will heat the Glass in a line between the Balls, and in a few

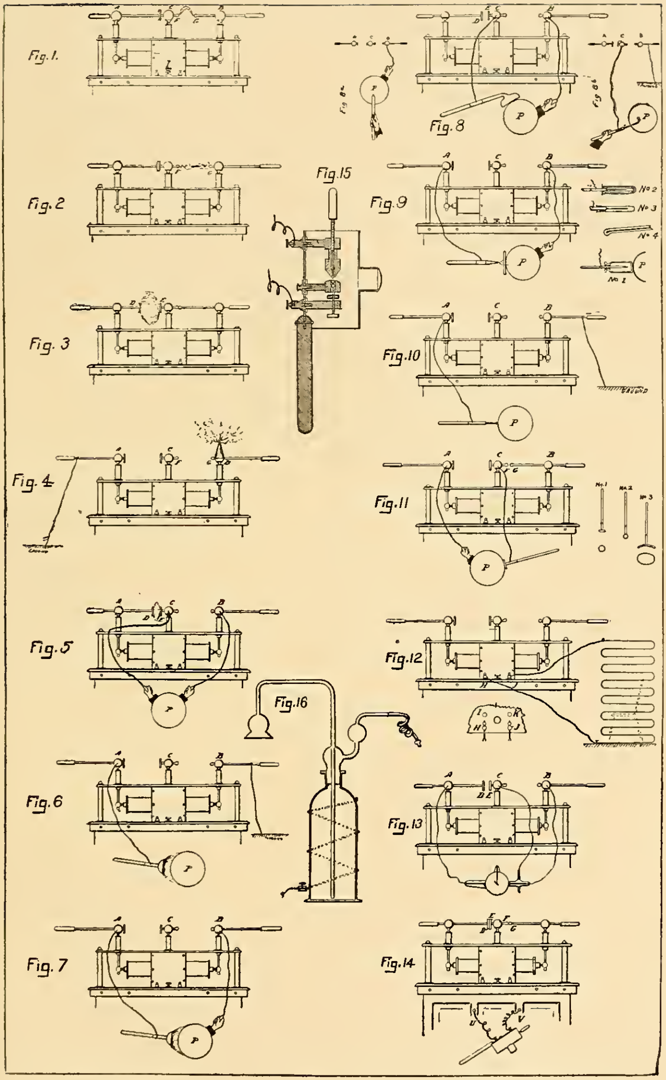

FIG. 74.—REDUCED COPY OF CHART SHOWING METHODS OF OBTAINING VARIOUS HIGH- AND LOW-FREQUENCY MODALITIES FROM DR. STRONG'S MACHINES.

moments will actually melt a hole through the Plate. The latter experiment should be performed with a piece of thin window glass, as the unequal expansion is liable to cause a thicker glass to explode.

10. If a long Glass Tube, sealed at one end, be attached to a rubber tube connected to a powerful Air-pump, and a Wire from each Terminal of the High-Frequency Apparatus be wound around the Tube at each extremity, no evidence of the passage of a Current will be seen on starting the Apparatus. If, now, the air be slowly withdrawn from the Tube, a faint blue thread will appear, changing to a red-violet pencil of light, extending through the Tube between the points where the wires are attached. The first thread-like flicker occurs when all but one-fifth of the original air has been removed, and the red pencil when only one-twentieth of the air remains. Increasing the exhaustion to one five-hundredth causes the pencil of light to enlarge until it completely fills the Tube. From this point up to one ten-thousandth of an atmosphere, causes the light to change from a red-violet to red-pink, pink, pale rose, and finally pure white. With a good Mercury Pump, we can carry the exhaustion still further, and at one fifty-thousandth, the inner surface of the Glass shows an apple-green Fluorescence. At one one-hundred-thousandth, most of the white light has disappeared, and at one one-millionth, it has completely gone and the Tube appears empty, but the green Fluorescence has become more intense. We have now in the Tube what is known as a "*Crookes Vacuum,*" the condition necessary for the production of the "*X-rays of Roentgen.*"

11. In 1896, the writer constructed several instruments for applying the High-Frequency Current to the Human Body, consisting of Glass Tubes from which most of the air had been exhausted, fitted with insulating Handles. In this

way the advantages of Vacuum Tubes for administering High-Frequency Currents in the treatment of local conditions was discovered, and the *Vacuum Electrode* was introduced into Electro-therapeutics. It is now in general use in all parts of the World, and is regarded as one of the most important factors in the treatment of Disease by High-Potential Currents. When first introduced by the writer, how-

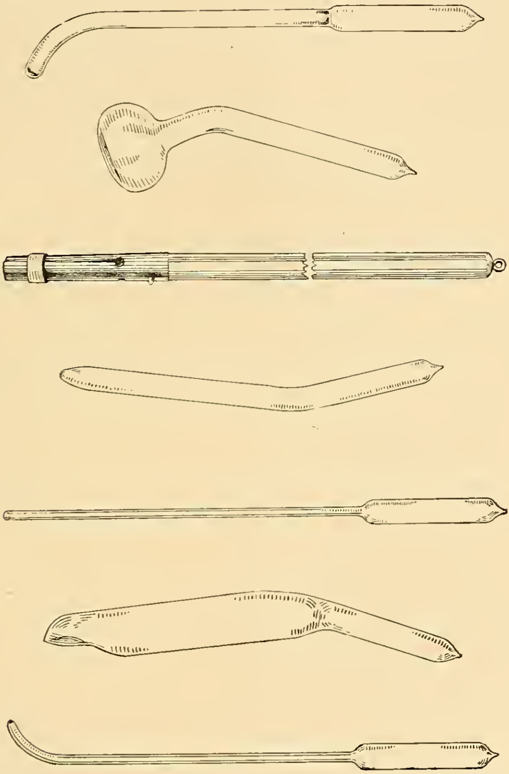

FIG. 75.—DR. SNOW'S SET OF VACUUM ELECTRODES.

ever, it was denounced as a "spectacular toy" by a number of Physicians who now employ it constantly in the treatment of their Patients.

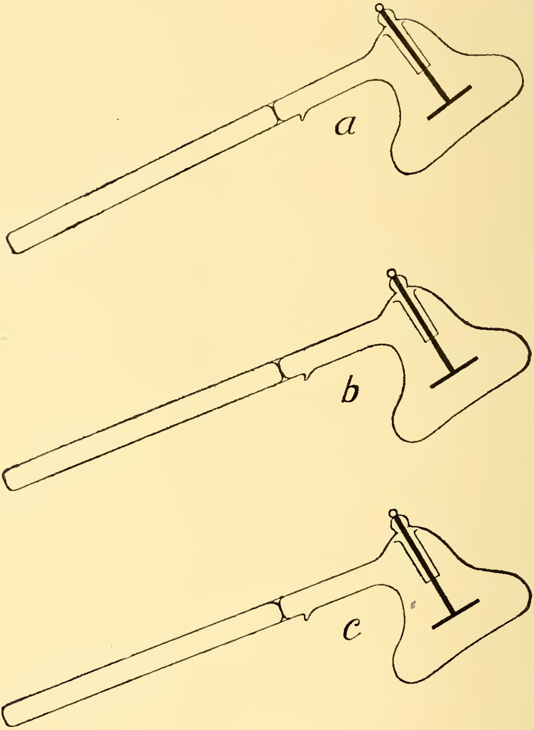

Fig. 76.—Dr. Strong's Set of Graduated Vacuum Condenser Electrodes, Exhausted to—*a*, Low ("Red"), *b*, High ("White"), *c*, Very High ("X-ray Vacuum").

12. When Vacuum Electrodes are used in the Therapeutic application of High-Frequency Currents, a two-fold effect is produced:—

a. *A general effect* due to the action of the High-Frequency Current, which increases Metabolism, relieves Congestion, stimulates the Vaso-motor System and promotes Nutrition and Vital Resistance. If a Vacuum Electrode is connected directly to the Terminal of a Resonator, the effects just mentioned will be confined to the tissues in the vicinity of the area treated. But if the Electrode be used to draw off the Resonator Current from the Patient, or if the writer's Bi-polar Technique be employed, the entire Organism will be subjected to the Vitalizing effect of the Current.

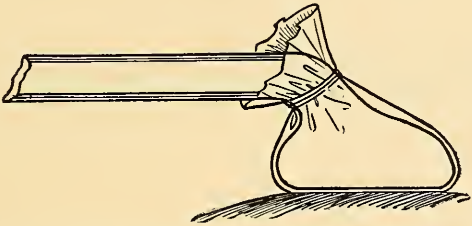

FIG. 77.—DR. STRONG'S VACUUM ELECTRODE, COVERED WITH FLANNEL OR CHAMOIS SKIN, FOR SUPERFICIAL COUNTER-IRRITATION.

b. The second effect is purely *local* and more or less superficial, and results from the action of *Ether Waves* of *Radiant Energy* generated by the Electronic Vibration in the Vacuum Tube. The nature of the effect depends upon the *wave length* and *frequency* of the Rays, or in other words, results from the degree of exhaustion in the Tube. The majority of Vacuum Electrodes possess what is called a "*Low Red Vacuum*," on account of the Red-Violet Color produced in the Tube. Electrodes of this type, when excited by a Resonator or Tesla Current, produce Local Sedative Effects, disperse Inflammation and Acute Congestion, sterilize superficial Septic Areas, promote Phagocytosis, stimulate Secretion and Absorption, and relieve Acute Local Pain. For the treatment of Muscular and Articular Rheumatism, Spinal Irritation and Cerebral Congestion, the Electrode should be applied through the Clothing, or still better, should be temporarily covered with one or more layers of thin Flannel, which should be stretched over the end of the Bulb and gathered with a rubber-band. With this arrangement the Current comes from the Electrode in a series of *fine Sparks* which produce slight Counter-irritation and stimulate the Peripheral Nerves. It is well to use the Electrode for a few minutes in direct contact with the Skin, and then repeat the process with the Cloth-covered Electrode. For the treatment of Sub-acute or Chronic Inflammation, Congestion or Hypertrophy, a so-called "*White-vacuum Electrode*" should be used, exhausted to about one ten-thousandth of an atmosphere. Persistent Gleet, Enlarged Prostate, Chronic Endometritis, Hypertrophic Rhinitis, and Ozena, are conditions in which treatment with the White-vacuum Electrode is indicated.

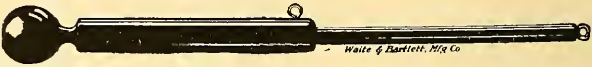

Fig. 78.—Dr. Piffard's Electrode for Obtaining his "Trans-resonator Effluve."

Obstinate Neuralgic Pain which refuses to yield to treatment with Low Vacuum Electrodes is frequently relieved by substituting a Tube exhausted to a White-vacuum. For the treatment of Indolent Ulcers, Tubercular Lesions, and Superficial Cancers, an Electrode should be used, exhausted to an "X-*ray Vacuum.*" The writer has recently devised a set of three "*Condenser Electrodes*" exhausted respectively to a *Red, White,* and *X-ray Vacuum.* Their action is similar to that of the ordinary Vacuum Electrodes but the local effects are much more powerful.

13. The Discharge from a Resonator or Tesla Coil is also used for the treatment of Local Conditions in the form of the "*Effluve*" and the "*Resonator Spark.*" The former is applied by means of a Wire Brush or Metal Point Electrode, connected directly to the Resonator Terminal. It produces superficial reaction, varying from a slight Erythema to actual Blistering, accompanied by intense stimulation of the local Circulation, and a more or less general increase in the activity of the Vaso-Motor System. Resonator Sparks are sometimes employed in cases of Paralysis, and as a substitute for Cauterization in Spinal Disease. A Metal Point Electrode is used, which is carefully moved toward the affected area until the Spark passes.

14. D'Arsonval Currents for direct, or indirect application are equally efficient whether derived from a Solenoid and Ruhmkorff Coil, or from a Tesla Apparatus. All of the writer's Machines of the latter type, are provided with Coils of heavy wire, separate from the Tesla Coil, which produce d'Arsonval currents of even greater volume than those obtained from European Apparatus.

D'Arsonval Currents owe their Therapeutic Value mainly to their stimulating action on the Chemical Processes of the Organism. They increase Tissue Combustion and Oxidation, and facilitate the Elimination of Waste-products. Nitrogenous Débris, which would otherwise form Uric Acid is converted into Urea, and the Peripheral Circulation is increased through Vaso-motor stimulation. In addition to these effects the d'Arsonval Current is of value for the relief of acute Congestion and Stasis as in the early stages of

Pneumonia, Bronchitis, Tonsilitis, etc. To obtain these effects the Current should be used directly, by means of Sponge-covered Electrodes applied to the affected area. They should be kept in constant motion in order to avoid superficial irritation.

15. The superiority of the *Tesla Currents* used in accordance with the System of Technique originated by the writer, lies in the fact that the *general effects* of the *d'Asronval Current* are produced simultaneously with the *local effects* of the *Resonator Discharge,* in addition to which there is a *general stimulation of the Trophic Centers, increase in Vital Resistance* and an apparently real *addition to the Vitality of the Organism,* which, so far as the writer's observation is concerned, is not obtainable from any other Therapeutic agent known at the present time.

16. For general High-Frequency treatment, one Pole of the Tesla Apparatus is connected with the Patient by a Metal Hand Electrode, a similar Electrode in the other hand being connected with the "Dummy" Terminal; both the Disks and Balls are separated at the beginning of the treatment. If the Disks be now brought together until an Effluve passes between them, the Patient will experience a sensation like that produced by a Faradic Coil, attended with slight Muscular Contractions in the wrist, due to the production of *Low Frequency Impulses* in the *High-Frequency Stream.* This is an example of the writer's "*Multi-Frequency Currents,*" in which Electrical Vibrations of different Frequencies are administered to the Patient simultaneously. Widely different Therapeutic effects are produced by different combinations of Vibrations. The extreme Frequency of the Tesla Current and the freedom with which it passes through the tissues, renders it an ideal *medium* or *carrier* for *Electrical Vibrations of lower Frequencies.*

Believing that the various Functions of the Body are maintained or performed by the action of Nerve Vibrations of different, yet definite Frequencies, the writer is firmly convinced that the successful elimination of Disease and the maintenance of a high standard of Health will be brought about by an intelligent and scientific employment of Electrical Vibrations, through the elaboration of the principle exemplified in his *Multi-Frequency System.* For a more detailed description of the latter, the Physician is referred to the writer's Treatise on High-Frequency Currents.

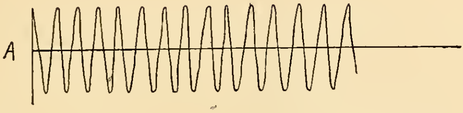

Fig. 79.—*A*, Theoretical Curve of a Pure Tesla Current.

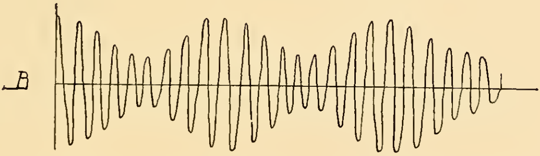

Fig. 80.—*B*, Same Current Carrying a Superimposed Wave of Lower-frequency: Dr. Strong's "Multi-Frequency Current."

17. For the Physician who does not care to study in detail the various methods for the application of the Tesla Currents, the following technique may be recommended:—

A circular Plate of Zinc about a foot in diameter, is permanently connected to a rubber-covered Conducting Cord, which is attached to one Terminal of a Tesla Apparatus.

The Plate is placed upon a Chair and upon it is placed a thick Cushion, the bottom of which is formed of sheet rubber; the Patient sits upon this Cushion and is then treated by means of the "*Effluve,*" *Spark,* or *Vacuum Electrode,* connected either to the other Terminal of the Tesla Coil, or to a Grounded Wire. The Terminal to which the Electrode is attached is used in exactly the same way as the Pole of a Resonator, and the same Local Action is produced, with the addition of the Constitutional Effects described in the preceding paragraphs.

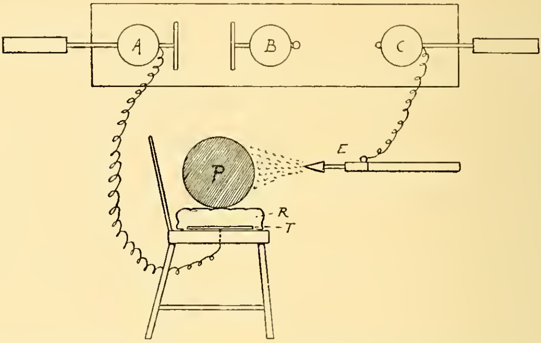

FIG. 81.—DR. STRONG'S "AUTO-CONDENSATION EFFLUVE" FROM CURRENT OF HIGH POTENTIAL AND FREQUENCY.

A B C, Tesla-coil Terminals. *E,* Metal point Electrode. *T,* Metal Plate, in *R,* Rubber Covered Cushion. *P,* Patient.

CHAPTER IX

THE ROENTGEN RAYS

1. The X-rays were discovered in 1895 by Professor Roentgen of Wurzburg, while studying the Electrical Discharge in a Crookes tube, exhausted to one one-millionth of an atmosphere.

2. The *X-rays* are *Waves* or *Pulses* in the Ether of very High-Frequency and a Wave-length so short that they pass through many solid bodies almost as readily as Light passes through glass. Metals, and as a rule other solid substances, absorb the X-rays in a degree proportional to their density; thus heavy metals like Lead and Iron, are almost opaque, while Aluminum, which is light, offers but little resistance to their passage. There are certain exceptions to the above rule, notably the Diamond, which is almost transparent, while Glass and Quartz absorb a large percentage of the Rays. The Human Bones are moderately opaque, the Organs and Muscles less so; the Lungs, on account of their spongy character, being almost transparent.

3. The X-rays are invisible to the Human Eye, but may be converted into Light by the use of Screens of cardboard coated with some highly Fluorescent substance such as *Barium Platinum Cyanide, Calcium Tungstate, Willemite,* etc. Screens of this character become luminous in proportion to the strength of the X-rays which fall upon them. If the Hand be held between such a Screen and a source of X-rays, the Bones, which absorb most of the Rays, will appear as

dark shadows. The Flesh, which allows more of the X-rays to pass, casts a lighter shadow, while the unimpeded Rays will cause the remainder of the Screen to be brilliantly illuminated. We speak of "Seeing the Bones through a Fluroscope," but in reality we are looking at a "Shadow Picture," produced by the conversion of the X-rays into Light by the Fluorescent Chemical on the Screen.

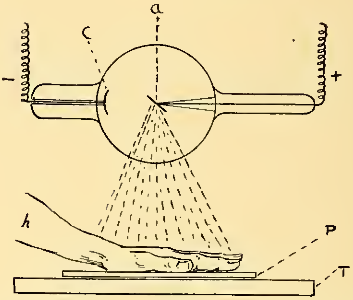

FIG. 82.—METHOD OF TAKING A "SKIAGRAPH."
a, Anode. *c*, Cathode. *h*, Hand of patient. *P*, Sensitive plate enclosed in opaque envelope. *T*, Table.

4. If a sensitive Photographic Plate, sealed in an opaque envelope, be substituted for the Fluorescent screen in the above experiment, the X-rays will produce the same effect as Light, and on development, a permanent picture or *"Skiagraphic" Negative* will be obtained. The length of the exposure will depend on the intensity of the Rays and the thickness of the Tissue through which they pass.

5. X-ray Tubes are of three types, intended for use respectively with a *Static Machine*, a *Tesla Apparatus*, and a *Ruhmkorff Coil*. The Static Tube is of the simplest construction, and consists of an *Aluminum Cathode*, shaped like a *Concave Reflector*, and a *plane Platinum Anode* placed in the

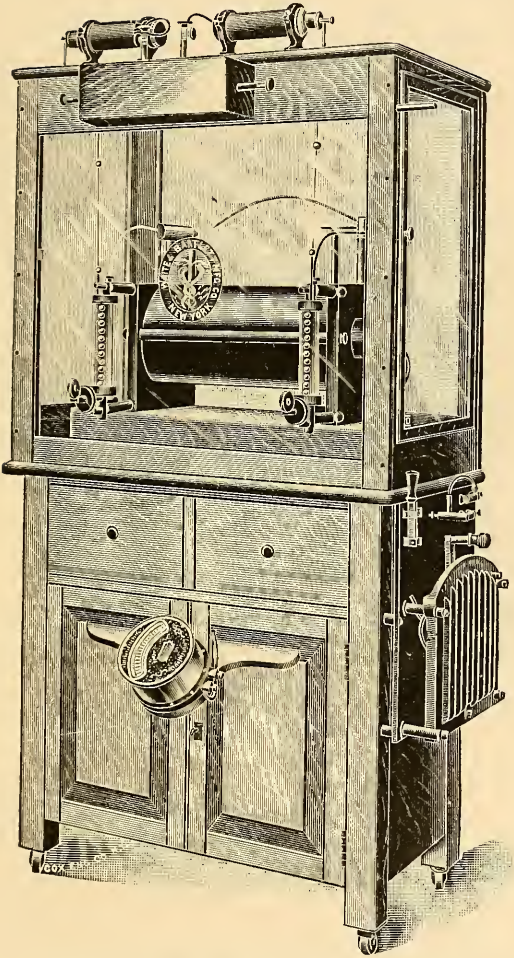

FIG. 83.—RUHMKORFF COIL FOR X-RAY WORK.

Focus of the Rays from the Cathode, and at an angle of 45 degrees with the axis of the Tube. When in operation, the "Cathode Rays," consisting of Streams of Electrons, are projected from the surface of the Cathode with the velocity of Light and strike the Anode at a common Focus, from which they are reflected at right angles toward the side of the Tube. At this point each Electron is stopped, but the *Impulse* which it has communicated to the Ether is transmitted to the space outside the Tube in a line continuous with the path of the Electron. (See annexed illustration.)

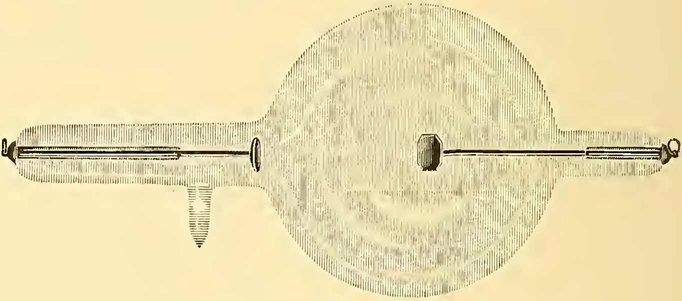

Fig. 84.—Light Anode Tube for Static Machine.

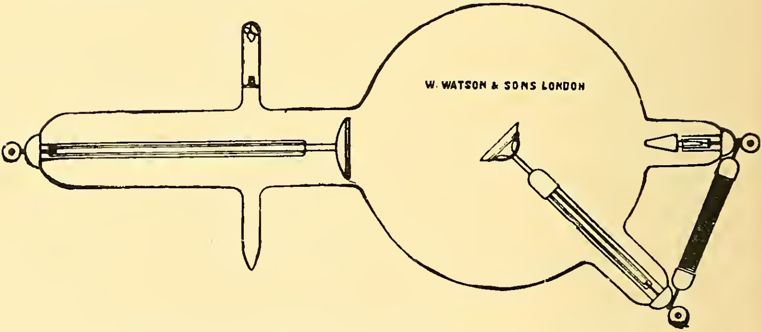

Fig. 85.—Ruhmkorff Coil Tube for Light Work.

It will be seen, therefore, that X-rays radiate from a point, and that their intensity is inversely proportional to the square of the distance from the Anode. This fact should be considered in determining the time of exposure in taking a Skiagraph. The penetrability of X-rays increases with the degree of exhaustion or Electrical Resistance of the Tube. Tubes of high exhaustion are called "*Hard Tubes,*" and are used in examining thick structures such as the Trunk and Thigh. They require a High Voltage. Static Tubes are of this type, but few Static Machines furnish sufficient Amperage for heavy X-ray work. With a Ruhmkorff Coil "*Soft Tubes,*" having a lower degree of exhaustion are generally employed. They require less Voltage than Hard Tubes, but a large Amperage must be used in order to obtain penetration, the Rays from these Tubes being more readily absorbed. These Tubes get very hot and require heavy Anodes or Water-chambers to disperse the Heat. The degree of exhaustion gradually increases through constant use

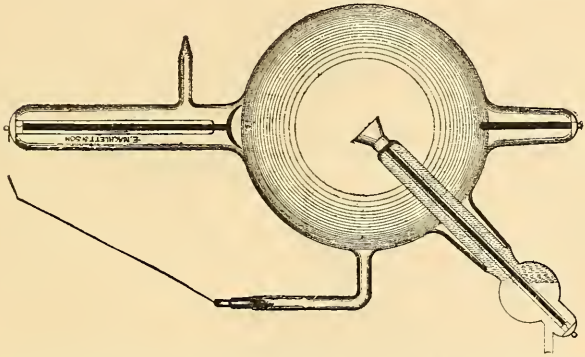

FIG. 86.—WATER-COOLED RUHMKORFF COIL TUBE FOR VERY HEAVY WORK.

some of the residual Air Particles being driven into the Glass or absorbed by the Platinum Anode when the Tube is in operation. When the resistance becomes too high the "*Vacuum*" may be "*lowered*" by admitting Hydrogen Gas through the pores of a red hot Platinum Tube, or by liberating Oxygen by heating Manganese Di-oxide contained in a small Side-tube. Some Tubes liberate gas automatically when their resistance becomes too high, and are said to be "*Self-regulating.*" For use with a *Tesla Current* a special

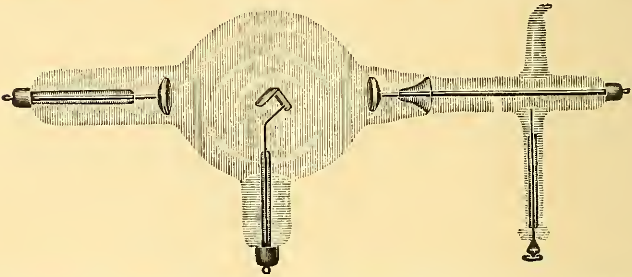

FIG. 87.—THOMPSON DOUBLE-FOCUS TUBE FOR USING BOTH PHASES OF A HIGH-FREQUENCY CURRENT.

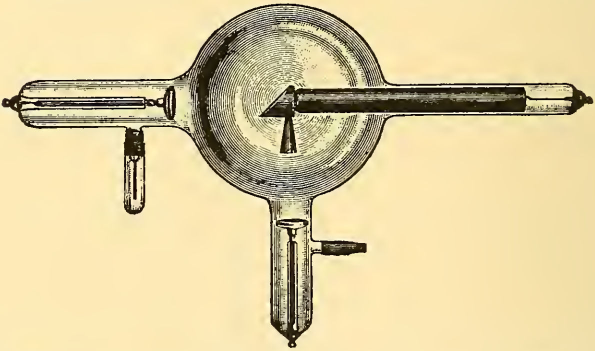

FIG. 88.—HIGH-FREQUENCY TUBE USING THE ALTERNATIONS IN ONE DIRECTION ONLY.

form of Tube is necessary, owing to the alternating character of the Electrical Impulses. In the "*Thompson Double-focus Tube*" the Terminals of the Coil are connected to two Cathodes, each of which is provided with a Platinum Target or Reflector, formed of a single "V-shaped" plate. The Rays are sent out in parallel Streams, first on one side of the apex of the platinum V, and then on the other. In a well-made Tube the two Streams coalesce and act as one, but if the Cathodes are not accurately focused, a double outline will be produced on the Plate or Screen. For accurate work, therefore, it is better to employ a Tube in which one set of

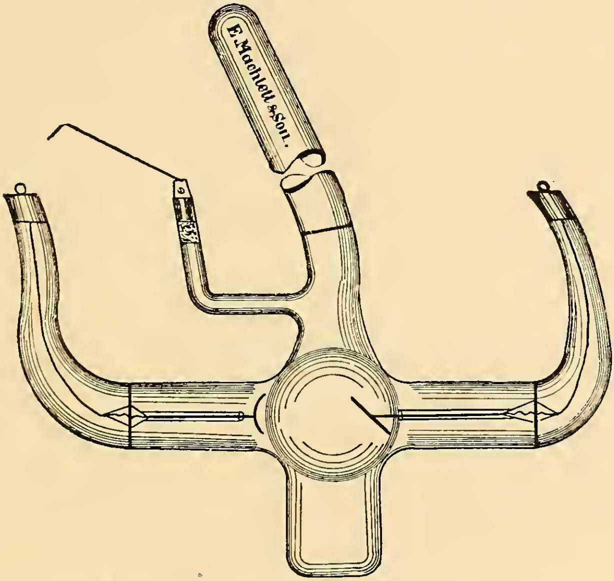

FIG. 89.—DR. GEYSER'S "CORNELL" TUBE (APPLIED DIRECTLY TO THE SURFACE TO BE TREATED).

Cathode Rays is "*choked,*" or *deflected* so as to allow of a *single stream* of X-rays to fall upon the Plate. The details of these Tubes may be seen in the accompanying illustrations.

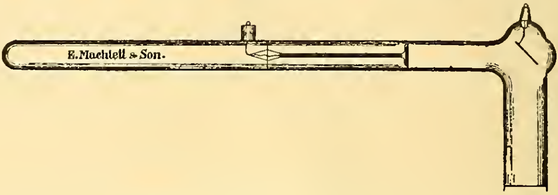

FIG. 90.—DR. BESSER'S THERAPEUTIC X-RAY TUBE FOR SMALL AREAS.

6. X-rays have been extensively used in Therapeutics in the treatment of Cancer and Lupus. The latest conclusions, however, seem to prove that the X-ray alone, seldom produces permanent Cures. A great drawback to the Therapeutic use of X-rays from a Static Machine or Ruhmkorff Coil, is the liability ,of producing serious "*Burns,*" of the

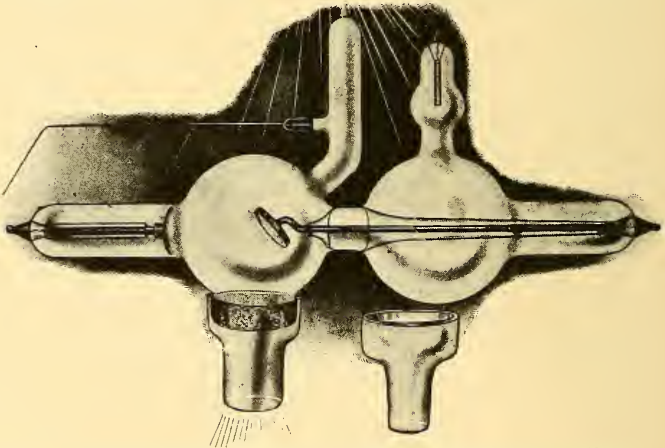

FIG. 91.—DR. PIFFARD'S SAFETY TUBE FOR TREATING BY X-RAY.

superficial Tissues, accompanied by extensive Necrosis and requiring weeks or months to heal. The use of a *diffused X-ray* combined with the High-Frequency Current, as in treatment with the writer's "*X-ray Electrodes*" has given excellent results in Malignant Growths, Lupus, Chronic Ulcers, and other Indolent Conditions. It is rapidly replacing the older form of X-ray treatment.

CHAPTER X

PHOTO-THERAPY AND THE ULTRA-VIOLET RAY

1. The use of Light Waves for the treatment of Disease was first studied scientifically by the late Dr. Finsen. He employed the Radiant Energy from the Sun, and subsequently from heavy Arc Lamps. He found the Rays above, and including, the Blue to be of value in the treatment of

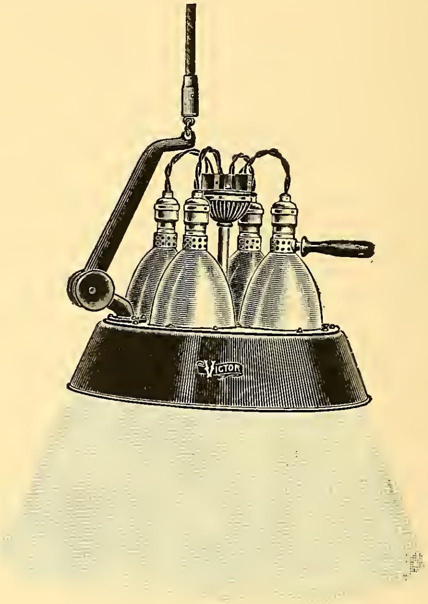

Fig. 92.—500 C. P. Incandescent Lamp for Photo-therapy.

Indolent Ulcer, Superficial Cancer, and especially Lupus. His method involved the use of a powerful 80-Ampere Arc Lamp, using heavy Carbons containing Salts of Iron; the Rays being conducted to the affected area by a Tube or Telescope containing Chambers filled with Alum, and Alkaline Copper-Sulphate Solutions between Plates of Quartz Crystal. After passing through these Chambers only the Blue, Violet and Ultra-Violet remain, the Heat Rays being absorbed by the Alum Solution, and the Red and Yellow Rays by the Copper Solution. The area to be treated is

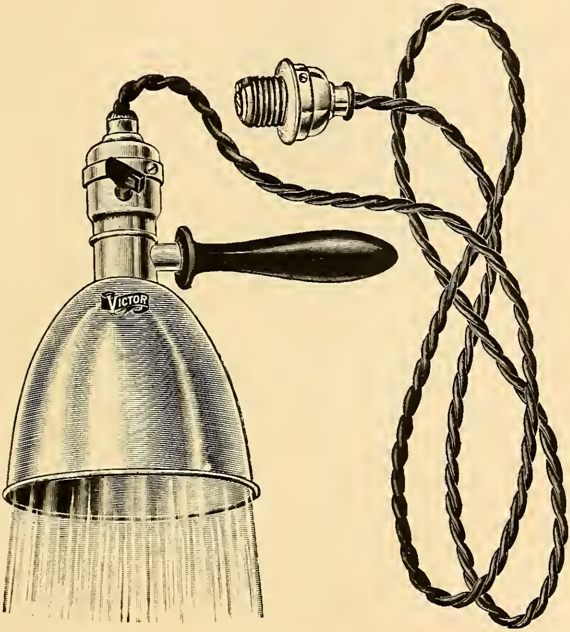

FIG. 93.—SMALL INCANDESCENT LAMP.

compressed by a Convex Quartz Lens which drives the Blood out of the Capillaries, and renders the Tissues less opaque to Ultra-Violet Rays. Daily Sittings of one hour, are given until the Lesion is healed; a year or more being sometimes required to effect a Cure.

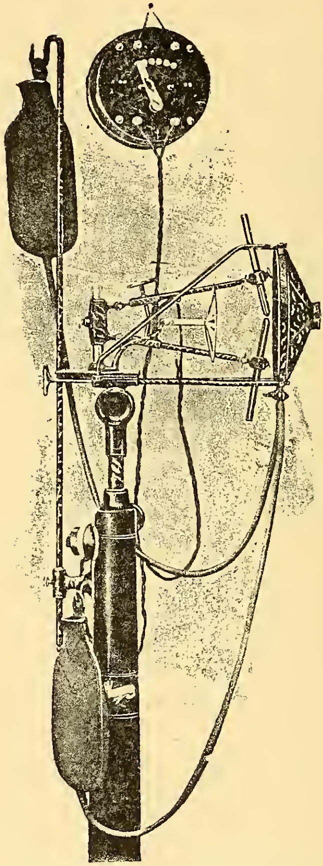

FIG. 94.—VICTOR ARC LAMP FOR LIGHT TREATMENT.

2. Ether Waves of different Frequencies differ in their Therapeutic action. There are, therefore, three different forms of Photo-therapeutic treatment.

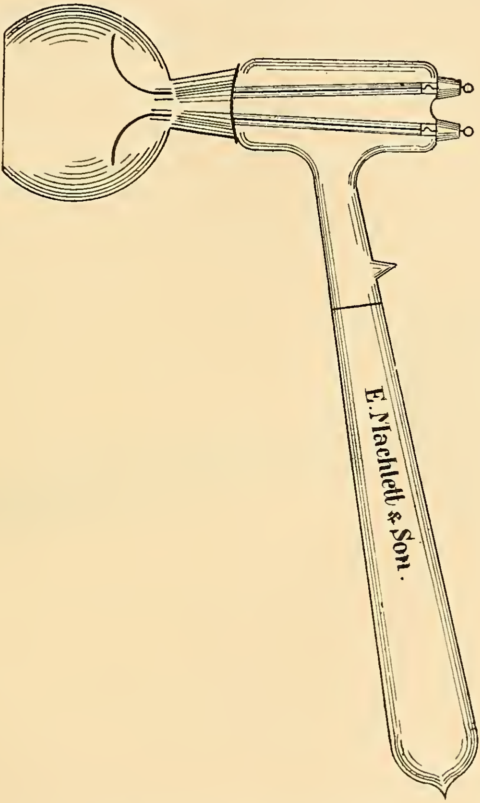

FIG. 95.—VACUUM LAMP FOR ULTRA-VIOLET RAYS, WITH QUARTZ LENS GROUND IN.

(a) Treatment employing Waves of *Low Frequency,* such as *Heat Waves, Infra-red, Red, Orange* and *Yellow Light Waves.*

(b) *Finsen Treatment,* described above, using Rays from the *Green* to a wave length of about 275 microns in the *Ultra-Violet.*

(c) Treatment with *Rapid Ultra-Violet Rays* of 200 microns and less. These radiations are obtained by discharging the Condenser of a Tesla Apparatus across a short Air Gap between Iron or Steel Electrodes; or by the use of Dr. Piffard's "*Spark Lamp*" in connection with a Ruhmkorff Coil. Rays from these Lamps cause brilliant Fluorescence in Willemite, Calcite, Uranium Glass, Quinine Solution, etc.

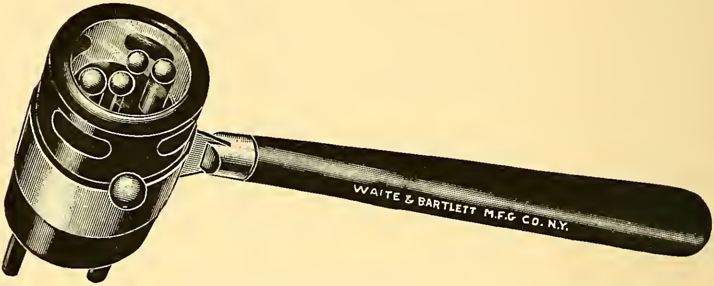

FIG. 96.—DR. PIFFARD'S SPARK-GAP LAMP LOR ULTRA-VIOLET RAYS.

3. The first of these methods involves the use of the "*Leucodescent Lamp,*" *Incandescent Light Baths,* etc. Favorable results have been obtained by their use in *Herpes, Zoster* and other forms of superficial *Neuritis, Neuralgia, Rheumatism,* and Skin Diseases such as *Eczema, Psoriasis* and the *Exanthemata.*

4. The Second form of treatment has been considered in paragraph 1. Small Arc Lamps, using ten Amperes, or less, are not sufficiently powerful for satisfactory treatment by

Finsen's methods, but are of value when used as generators of slow Rays, as in the preceding paragraph.

5. Rays of the Third class are almost entirely absorbed by glass, and Dr. Piffard has found that even the Quartz Plate stops some efficient Rays. Excellent results are obtained from the use of this method in diseases of the superficial layers of the Skin.

CHAPTER XI

THE THERAPEUTIC USE OF OZONE

1. Wherever High-Frequency or High Potential Currents pass across Air-Gaps in the form of an "*Effluve*" or *Brush Discharge,* some of the Oxygen Molecules, (containing two atoms each), will be broken up, and molecules of Ozone, each of which contains three Oxygen atoms, will be formed.

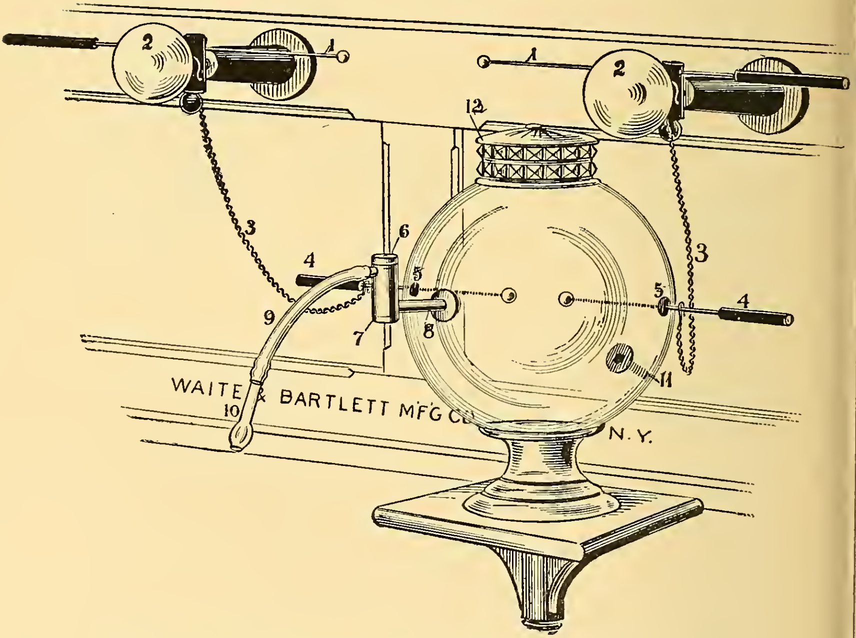

Fig. 97.—Ozone Generator for Use with Static Machine.

Arcs, on the other hand, tend to produce *Nitrous Vapors* from the Nitrogen and Oxygen of the Air.

2. Ozone is an active Germicide and Destroyer of Septic and Putrefactive Products. Treatment by Vacuum Electrodes attached to High-Frequency Generators produces Ozone in the superficial Tissues, and is, therefore, of value in Septic and Infectious Conditions of the Skin and Mucous Membrane. Pure Ozone mixed with Air may be inhaled with benefit in *Pulmonary Tuberculosis, Catarrhal Bronchitis,* etc.

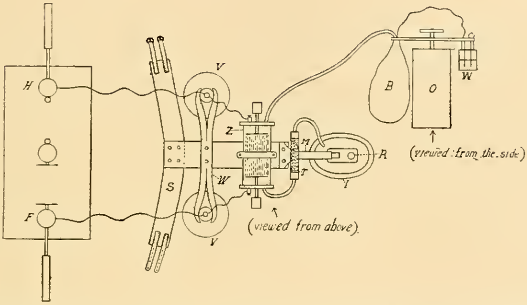

FIG. 98.—DR. STRONG'S NEW APPARATUS FOR TREATING PULMONARY TUBERCULOSIS BY A COMBINATION OF PURE OZONE, OXYGEN, ESSENTIAL OILS, VIOLET LIGHT AND HIGH-FREQUENCY CURRENTS.

H F, Terminals of Tesla coil. *S,* Strap to attach apparatus to patient. *V V,* Vacuum condenser electrodes. *W,* Wooden framework. *M,* Spring support for inhaling mask. *Z,* Ozonizing chamber (glass cylinder in which oxygen is decomposed by the "Effluve" discharge). *I,* Tube containing essential oils, etc. *I,* Inhaling mask or cone. *O,* Oxygen tank with bag and wash bottle.

3. The Poisonous Nitrous Fumes, above mentioned, must be removed before Ozone can be safely used for Inhalation. Several types of Ozone Generators are on the market, most

of which employ "*Essential Oils*" containing *Camphor* or *Terpene Products* to absorb the Nitrous Fumes.

4. In the writer's recently invented Apparatus for the treatment of Pulmonary Tuberculosis, Ozone is produced by the action of the High-Frequency Effluve on a Stream of *pure Oxygen Gas;* in this way the objectionable Nitrous Vapors *are entirely eliminated.* The *Ozonized Oxygen* is charged with the Vapors of *Thymol, Eucalyptus,* and *Oil of Pine-needles,* and is inhaled in a freshly formed state, while the Patient is being simultaneously subjected to the local action of a Current from a Tesla Coil, each Pole of the latter being connected to a powerful Vacuum Electrode of the Condenser type, one of which is placed over each Lung. In this manner the Patient receives at a single sitting the combined action of the *High-Frequency Current,* the *Radiant Energy from the Electrodes, pure Oxygen partially Ionized,* mixed with *pure Ozone* and with *Antiseptic Aromatic Vapors.* Although of too recent invention to permit of clinical verification, the writer is convinced that in the above method we have attained a most promising treatment for Pulmonary Tuberculosis.

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